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## NODE DEVICE

### Background of the Invention

#### 5 Field of the Invention

The present invention relates to a node device, and in particular to a node device which composes a communication system with a terminal, or with a terminal and a location registering server.

10 Recently, a next generation mobile communication system has been studied in research institutions, standardization groups, and the like all over the world. The next generation mobile communication system aims at offering multi-media services including a high-speed data  
15 communication to the extent of 2Mbps.

Particularly, it is expected that packet communication services including the Internet will become the core services of the next generation of mobile communications in lieu of present services mainly using  
20 voice.

Furthermore, the study of the communication system has started where a mobile and a fixed station are integrated. In such an integrated communication system, it is important to reliably transmit a packet from a source  
25 terminal to a destination terminal.

#### Description of the Related Art

Current concept diagrams and problems of a mobile communication packet system realized by a cellular  
30 communication network in Japan and Europe are mentioned in a mobile packet communication system of the Unites

States Patent Application No.09/482,712 (filed on January 13, 2000). This entire application is hereby incorporated by reference.

Fig. 32 shows an arrangement of the mobile packet communication system in the above-mentioned application. This communication system is composed of location registering servers 30\_1 and 30\_2, and node devices 20\_1-20\_4, each node device having a respective area 21\_1-21\_4 of communication.

Addresses [ADR1]-[ADR6] are assigned to the location registering servers 30\_1, 30\_2, and the node devices 20\_1-20\_4.

Furthermore, the communication system includes mobile terminals (hereinafter simply referred to as terminals) 10\_3, 10\_4, 10\_1, and 10\_2, which are respectively located in the areas 21\_1-21\_3, and addresses [1.1.1], [1.1.2], [2.1.1], and [2.2.1] are respectively assigned to each of the terminals 10\_1-10\_4.

It is to be noted that in Fig. 32 a subscriber node and a gate node in the above-mentioned application are not distinguished therebetween and simply referred to as a node device. In addition, reference numerals or characters of a terminal, a node device, and the like are used in modified forms.

The location registering servers 30\_1 and 30\_2 are established corresponding to an upper figure of a destination address (e.g. IPv4 and IPv6) of the packet, and are respectively provided with location registering tables 31\_1 and 31\_2 which register the address of the terminal corresponding to the address of the node device having the area where the terminal is located.

For instance, the addresses [1.1.1] and [1.1.2] of the terminals 10\_1 and 10\_2, the address of which is represented by [1.X.X ("X": don't care)], are made corresponding to the address [ADR5] of the node device 20\_3  
5 having the area where the terminals 10\_1 and 10\_2 are located to be registered in the location registering table 31\_1.

Similarly, the addresses [2.1.1] and [2.2.1] of terminals 10\_3 and 10\_4, the address of which is  
10 represented by [2.X.X], and the addresses [ADR3] and [ADR4] of the node devices 20\_1 and 20\_2, are registered in the location registering table 31\_2.

Also, the servers 30\_1 and 30\_2 are provided with a function of transferring the packet based on the  
15 information of the location registering tables.

The node devices 20\_1-20\_4 have location information tables 22\_1-22\_4 (only 22\_2 is shown) for storing the addresses of the terminal and the destination node device, and a server retrieval table 40 for retrieving the address  
20 of the corresponding location registering server from the upper figure of the destination address of the packet.

Fig. 33 shows an operation example of the packet transfer in the mobile packet communication system shown in Fig.32. Hereinafter, the operation when a user packet  
25 71 is transmitted from the terminal 10\_4 to the terminal 10\_1 will be described in the order of processing steps.  
Step S1: The terminal 10\_4 transmits the user packet 71 including the address [1.1.1] indicating "addressed to the terminal 10\_1" to the node device 20\_2.  
30 Step S2: The node device 20\_2 retrieves the address [ADR1] of the server 30\_1 corresponding to the address [1.1.1]

of the terminal 10\_1 from the server retrieval table 40.

Step S3: The node device 20\_2 adds the address [ADR1] of the server 30\_1 to the received user packet 71 to be transferred to the server 30\_1 as an inter-node packet 81.

5    Step S4: The server 30\_1 retrieves the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located from the location registering table 31\_1.

Step S5: The server 30\_1 transfers an inter-node packet 82, in which the destination address of the received packet

10    81 is rewritten to [ADR5], to the node device 20\_3.

Step S6: The server 30\_1 notifies the node device 20\_2 of the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located based on a source address [ADR4] of the packet 81.

15    Step S7: The node device 20\_3 transmits the packet 71, that is the packet 82 from which the address [ADR5] of its own device is removed, to the terminal 10\_1, so that the terminal 10\_1 receives the same.

Step S8: The node device 20\_2 updates the address of the

20    node device having the area where the terminal 10\_1 is located in the location information table 22\_2 to [ADR5] or adds [ADR5] to the node device address.

Step S9: The next user packet 71 addressed to the terminal 10\_1 arrives at the node device 20\_2.

25    Step S10: The node device 20\_2 retrieves the location information table 22\_2 to obtain the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

Step S11: The node device 20\_2 directly transfers to the

30    node device 20\_3 an inter-node packet 83, that is the received packet 71, addressed to the terminal 10\_1 and

added with the address [ADR5] of the node device 20\_3.

Step S12: The node device 20\_3 transmits the user packet 71, that is the packet 83 of the node device 20\_3 from which the address [ADR5] is removed, to the terminal 10\_1.

- 5        Thus, the packets 71 which the terminal 10\_4 subsequently transmits are received by the terminal 10\_1.

In such a communication system composed of such a node device, a packet loss occurs when the terminal 10\_1 moves to an area of another node device.

- 10        This will be described by referring to Fig.34 which shows an operation after a packet transfer operation of Fig.33.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

- 15        Step S2: The terminal 10\_1 makes a location registration to the communication system.

Step S3: The node device 20\_4 retrieves the address [ADR1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1 from the server  
20        retrieval table 40.

Step S4: The node device 20\_4 transmits location registering information to the location registering server 30\_1.

- 25        Step S5: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [ADR6].

Step S6: The user packet 71 addressed to the terminal 10\_1 arrives at the node device 20\_2.

- 30        Step S7: The node device 20\_2 retrieves the address [ADR5] of the node device 20\_3 having the area where the terminal

10\_1 is located from the location information table 22\_2.

Step S8: The node device 20\_2 transfers to the node device 20\_3 the inter-node packet 81, that is the received packet 71, addressed to the terminal 10\_1 and added with the address [ADR5].

Step S9: Since the node device 20\_3 does not have the area where the destination terminal 10\_1 is located, the user packet 71 cannot be transmitted to the terminal 10\_1.

Hereafter, every time the terminal 10\_4 transmits the user packet 71 to the terminal 10\_1, steps S6-S9 are repeated, so that the user packet 71 is discarded.

As mentioned above, when the destination terminal moves to a different destination node device in such a mobile packet communication system, the user packet received at a former node device cannot be delivered to the destination terminal, so that a communication quality deteriorates due to the occurrence of packet loss.

Also, since the location information of the destination terminal cached in the location information table of a source node device is not updated, there has been a problem that the packet transfer to the former node device is inevitably continued although the destination terminal has already moved.

## Summary of the Invention

Accordingly, the present invention has the following two objects in a node device that composes a communication system with a terminal, or with a terminal and a location registering server:

Object 1: To reduce packet loss which occurs when a destination terminal moves to an area of another node

device.

Object 2: To reduce the occurrence of continuous packet transmission to a former node device having an area where the destination terminal was located because stored

- 5 location information of the destination terminal is not being updated in a source node device.

The node device according to the present invention offers the following two main methods respectively for achieving the above-mentioned two objects:

- 10 Method 1 for achieving Object 1: The node device on a receiving side transfers the packet to a destination node device directly or through other devices, when the destination terminal of a received packet is not located in its own area.
- 15 Method 2 for achieving Object 1: The destination node device having the area where a terminal is now located notifies the former node device, having the area where the destination terminal was located before moving, of the address of its own device directly or through other devices,
- 20 when the destination terminal has moved to its own area.
- Method 1 for achieving Object 2: The node device on the receiving side notifies the source node device of the address of the destination node device, directly or
- 25 the received packet is not located in its own area.
- Method 2 for achieving Object 2: The destination node device notifies the source node device having the area where a source terminal is located, of the address of its own device directly or through other devices, when the
- 30 destination terminal has moved to its own area.

Hereinafter, the methods for achieving these objects

will be described.

It is to be noted that the node device according to the present invention can be connected to either a mobile network or a fixed network.

5 Also, the terminal capable of making a location registration can move between the node devices of the fixed network, the node devices of the mobile network, and between the node devices of the fixed network and the mobile network.

10 These movements of the terminal are described as "the terminal moves from the area of the node device to an area of another node device".

First of all, Method 1 for achieving the Object 1 will be described.

15 In order to achieve the above-mentioned Object 1, a node device on a receiving side of the present invention composes a communication system with a terminal and a location registering server, the location registering server comprises a location registering table, and the  
20 node device transfers a received packet to a destination node device having an area where a destination terminal to which the packet is to be transferred is located when knowing an address of the destination node device, while otherwise transfers the packet to the destination node  
25 device by referring to the location registering table, both when the destination terminal is not located in its own area.

Fig.1 shows an operation principle of a node device according to the present invention which composes the  
30 communication system with the terminal and the location registering server. The arrangement of the communication



system is the same as that shown in Fig.32.

This operation principle particularly relates to the node device on the receiving side which is a destination node device of an inter-node packet.

5        In this principle, schematically, when the destination terminal 10\_1 of the received packet 81 is not located in the area 21\_3 and the address of the node device 20\_4 having the area where the destination terminal 10\_1 is located is known, the node device 20\_3 on the receiving  
10       side transfers the packet 81 to the destination node device 20\_4.

When not knowing the address, the node device 20\_3 on the receiving side transfers the packet 81 to the destination node device 20\_4 directly or indirectly  
15       through other devices such as a source node device and a location registering server, based on the location registering table 31\_1.

The detailed operation will be described.

In Fig.1, as to the state before a packet transfer  
20       operation, the terminal 10\_1 is located in the area 21\_3 of the node device 20\_3, and the source node device 20\_2 stores the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.

25       Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the communication system.

Step S3: The node device 20\_4 retrieves the server  
30       retrieval table 40 to obtain the address [ADR1] of the location registering server 30\_1 corresponding to the

address [1.1.1]=[1.X.X] of the terminal 10\_1.

Step S4: The node device 20\_4 transmits the location registering information to the location registering server 30\_1.

- 5 Step S5: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [ADR6].

Namely, the location registering server 30\_1 stores,  
10 in the location registering table 31\_1, the address [1.1.1] of the terminal 10\_1 and the address [ADR6] of the node device 20\_4 having the area where the terminal 10\_1 is located made corresponding to each other.

- Step S6: The terminal 10\_4 transmits the user packet 71  
15 addressed to the terminal 10\_1 to the node device 20\_2.

Step S7: The node device 20\_2 retrieves the location information table 22\_2 to obtain the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

- 20 Step S8: The node device 20\_2 adds the address [ADR5] of the node device 20\_3 to the packet 71 to transfer the packet as the inter-node packet 81.

Step S9: The node device 20\_3 receives the packet 81.

- When the destination terminal 10\_1 is not located in  
25 the area 21\_3 and the address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located is known at this time, the node device 20\_3 directly transfers the packet 81 to the node device 20\_4.

- When not knowing the address [ADR6] of the node  
30 device 20\_4, the node device 20\_3 transfers the packet 71 addressed to the terminal 10\_1 included in the packet 81

to the node device 20\_4 having the area where the terminal 10\_1 is located directly or indirectly through other devices, thus the packet is transferred based on the location information (correspondence between the address  
5 [1.1.1] of the terminal 10\_1 and the address of the node device having the area where the terminal 10\_1 is located) registered in the location registering table 31\_1.

The above-mentioned operation enables the user packet 81, received at the former node device 20\_3 before  
10 the destination terminal 10\_1 has moved, to be transferred to the destination node device 20\_4 after the movement, thereby preventing the deterioration of the communication quality caused by the packet loss.

It is to be noted that although the user packet 71  
15 is transferred between the node devices included in the inter-node packet 81 or the like, hereinafter, the transfer between the node devices is occasionally referred to simply as "the user packet 71 is transferred between the node devices".

Further, the received packet may be transferred to  
20 the destination node device through the location registering server by referring to the location registering table.

Namely, in Fig.1, the node device 20\_3 on the  
25 receiving side transfers the packet 71 included in the inter-node packet to the location registering server 30\_1.

The location registering server 30\_1 obtains the address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 of the packet 71 is  
30 located by referring to the location registering table 31\_1 to transfer the packet 71 included in the inter-node

packet to the node device 20\_4.

In addition, the packet may be once sent back to a source node device, which obtains the new address of the destination node device from the location registering  
5 server to transfer the packet to the destination node device.

Namely, in Fig.1, when the destination terminal 10\_1 of the received packet 81 (packet 71) is not located in the area of the device 20\_3, the node device 20\_3 on the  
10 receiving side sends back the packet 71 to the source node device 20\_2.

The source node device 20\_2 which has received the packet 71 knows that the destination terminal 10\_1 of the packet 71 is not located in the area of the node device  
15 on the receiving side, and obtains the new address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located from the location registering server 30\_1 to directly transfer the packet 71 to the node device 20\_4.

Also, according to the present invention, the packet  
20 may be once sent back to a source node device, which transfers the packet to the location registering server, which further transfers the received packet to the destination node device by referring to the location  
25 registering table.

Namely, different from the above invention, when the packet 71 is sent back, the source node device 20\_2 determines that the destination terminal 10\_1 is not located in the area of the node device 20\_3 on the receiving  
30 side to transfer the packet 71 to the location registering server 30\_1.

Thus, the source node device 20\_2 leaves the transfer of the packet 71 to the location registering server 30\_1 in the same way as the node device 20\_3 on the receiving side as described above.

5       Also, when the packet is being transferred back to the source node device, the packet may be transferred back through the location registering server.

Namely, in Fig.1, when the destination terminal 10\_1 is not located in the area 21\_3, the node device 20\_3 on the receiving side requests the location registering server 30\_2 to transfer the received packet back to the source node device 20\_2.

The location registering server 30\_2 transfers the packet 71 to the source node device 20\_2 having the area where the source terminal 10\_4 is located by referring to the location registering table.

Thus, it is possible for the node device 20\_3 on the receiving side to send back the packet 71 to the source node device.

20       The source node device may also transfer the packet 71 to the destination node device directly or through the location registering server.

Also in the present invention, the address of the destination node device may be obtained from the location registering server so that the packet is transferred to the node device of the address obtained.

Namely, in Fig.1, when the destination terminal 10\_1 of the received packet 81 (packet 71) is not located in the area 21\_3, the node device 20\_3 on the receiving side inquires of the location registering server 30\_1 about the address [ADR6] of the node device 20\_4 having the area

where the destination terminal 10\_1 is located, so that the packet 71 is transferred to the node device 20\_4 of the address [ADR6] obtained, i.e. the destination node address.

5           This enables the node device on the receiving side to directly transfer the packet to the destination node device even when the destination terminal is not located in its own area.

10           The node device on the receiving side may further comprise a storage portion for storing an address of the destination terminal and the address of the destination node device made corresponding to each other, and the node device on the receiving side may transfer the received packet to the destination node device when the destination  
15           terminal of the packet is not located in its own area.

Namely, the node device on the receiving side has the storage portion for storing the address of the destination terminal and the address of the destination node device made corresponding to each other.

20           The node device on the receiving side transfers the packet to the destination node device of the (known) address stored in the storage portion, when receiving the inter-node packet addressed to the destination terminal from the source node device and the destination terminal  
25           is not located in its own area.

This enables the node device on the receiving side to directly transfer the packet (inter-node packet) to the destination node device even when the destination terminal is not located in its own area.

30           Also, in the present invention a transfer of the packet may be continued after receiving the packet until

a predetermined time elapses or a finish of the packet transfer is instructed.

This enables the node device 20\_3 on the receiving side to perform the packet transfer until the transfer of  
5 the packet which belongs to a predetermined packet communication is finished.

Furthermore, after the packet transfer is finished, the address of the node device stored in the storage portion can be deleted, so that a storage capacity in the  
10 storage portion can be reduced.

Hereinafter, Method 2 for achieving Object 1 will be described.

In order to achieve the above-mentioned Object 1, a node device of the present invention composes a  
15 communication system with a terminal, and the destination node device obtains an address of a former node device having an area where the destination terminal was located when the destination terminal has moved to its own area to notify the former node device of addresses of its own  
20 device and the destination terminal.

Fig.2 shows an operation principle of the node device according to the present invention which composes the communication system with the terminal and the location registering server. The arrangement of the communication  
25 system is the same as that shown in Fig.1.

It is to be noted that the location registering server is not related to the methods according to the next embodiment of the present invention.

In this operation principle, schematically, upon the  
30 movement of the terminal 10\_1 to the area 21\_4 of the node device 20\_4 as a trigger, the destination node device 20\_4

notifies the former node device 20\_3 of its own device address [ADR6] directly or indirectly through other devices, so that based on the address [ADR6], the node device 20\_3 can transfer the received packet 82 (packet 5 71) to the node device 20\_4.

The detailed operation will be described.

In Fig.2, as the state before the packet transfer operation, the terminal 10\_1 is located in the area 21\_3 of the node device 20\_3, and the source node device 20\_2 10 stores the address [ADR5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

15 Step S2: At this time, the address [ADR5] of the former node device 20\_3 having the area where the destination terminal 10\_1 was located is stored in the communication system (either the terminal or the node device).

Step S3: The terminal 10\_1 makes the location registration 20 to the communication system.

Step S4: The node device 20\_4 notifies the former node device 20\_3 directly or indirectly of its own device address [ADR6] by using the address [ADR5] of the former node device 20\_3.

25 Step S5: The former node device 20\_3 adds the address [1.1.1] of the terminal 10\_1 and the address [ADR6] of the destination node device to the location information table 22\_3 e.g. "for inter-node packet transfer".

By the above-mentioned operation, the node device 30 20\_3 having the area where the destination terminal 10\_1 was located before the movement will know the address



[ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 of the received user packet 71 is located.

5 This enables the former node device 20\_3 to transfer the packet 71 to the node device having the area where the destination terminal 10\_1 is located without discarding the packet 71, thereby preventing the deterioration of the communication quality caused by the packet loss.

10 Hereafter, the former node device 20\_3 performs the packet transfer to the node device having the area where the destination terminal 10\_1 is located, by performing the operation of the following steps S6-S10 as the node device on the receiving side as in the previous embodiments of the present invention.

15 Steps S6-S8: In the same way as steps S6-S8 in Fig.1, the terminal 10\_4 transmits the packet 71 addressed to the terminal 10\_1, and this packet 71 reaches the node device 20\_3 as the packet 81.

20 Step S9: The node device 20\_3 retrieves the location information table 22\_3 to obtain the address [ADR6] of the node device 20\_4 having the area where the terminal 10\_1 is located, or to know the destination node device.

25 Step S10: The node device 20\_3 transfers, to the node device 20\_4, the packet 82 (packet 71) in which the destination address [ADR5] of the received packet 81 is rewritten to [ADR6].

Also, every time the destination terminal 10\_1 moves to an area of another node device, the operation of this embodiment is performed, and the destination node device (latest or new destination node device) notifies the former or old node device of the address of its own device

whereby each of the former node devices transfers the received packet addressed to the destination terminal 10\_1 to the node device having the area where the destination terminal 10\_1 is located next.

5        Thus, the packet addressed to the terminal received by all of the former node devices is to be transferred to the latest destination node device.

Also, this embodiment may be further characterized in that the destination terminal may comprise a storage  
10        portion for storing the address of the former node device, and the destination node device may receive the address stored in the storage portion to notify the former node device of the received address of the address of its own device.

15        Namely, in Fig.2, the destination terminal 10\_1 has a storage portion 11\_1, which stores the address [ADR5] of the node device 20\_3 having the area where the terminal was located.

When the destination terminal 10\_1 has moved to the  
20        area 21\_4, the destination node device 20\_4 receives the address [ADR5] by a notification (e.g. location registration request) from the destination terminal 10\_1 or an inquiry from its own device.

The node device 20\_4 notifies the address [ADR6] of  
25        its own device and the address of the destination terminal to the former node device 20\_3 of the received address [ADR5].

This enables the former node device 20\_3 to know the  
30        address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1, which has moved outside of its own area 21\_3, is located.

Further, the storage portion may store the address of the node device with which the destination terminal has started a communication during the communication.

Namely, the storage portion 11\_1 of the destination terminal 10\_1 stores the address [ADR5] of the node device (hereinafter referred to as communication start node device) 20\_3 with which the destination terminal has started the communication. The destination node device 20\_4 notifies the communication start node device 20\_3 of the address [ADR6] of its own device and the address of the destination terminal.

Furthermore, when the destination terminal 10\_1 has moved to another node device 20\_5 (not shown; its address is [ADR7]) during the communication, the other node device 20\_5 notifies the communication start node device 20\_3 of the address [ADR5] stored in the storage portion 11\_1 of its own device address [ADR7].

Thus, every time the destination terminal 10\_1 moves to an area of a latest node device, the latest node device notifies the communication start node device 20\_3 of the addresses of its own device and the destination terminal. Even if the destination terminal 10\_1 subsequently moves to another area during the communication for instance, it is possible for the communication start node device 20\_3 to know the address of the node device having the area where the destination terminal 10\_1 is located at present.

Also, in the present embodiment, the storage portion may store all of addresses of former node devices having areas where the destination terminal has been located from a communication start to a present time, and the destination node device may receive the addresses to

notify all of the former node devices of the addresses of its own device and the destination terminal.

Namely, in Fig.2, the storage portion 11\_1 stores all of the addresses of the node devices having the areas where the destination terminal 10\_1 has been located from the communication start at the node device 20\_3 to the present time. For instance, the storage portion 11\_1 stores all of the addresses of the node devices 20\_3 and 20\_6-20\_8 (not shown), which the destination terminal 10\_1 has passed when moving from the node device 20\_3 to the node device 20\_4.

The destination node device 20\_4 notifies all of the former node devices 20\_3 and 20\_6-20\_8 of the address [ADR6] of its own device and the address of the destination terminal.

Thus, during the communication, all of the former node devices 20\_3 and 20\_6-20\_8 having the areas where the destination terminal 10\_1 was previously located know the address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located at present, and it becomes possible to transfer the received packet addressed to the destination terminal 10\_1 without being discarded.

In the present embodiment the destination node device may further comprise a storage portion for storing the address of the former node device stored in the storage portion of the destination terminal and the address of the destination terminal made corresponding to each other, and the destination node device may notify the former node device of the address stored in the storage portion of the addresses of its own device and the destination terminal

when the destination terminal has moved from its own area to an area of a latest node device having the area where the destination terminal is located at present and the latest node device has notified the address of its own  
5 device.

Namely, the destination node device 20\_4 stores the address [ADR5] of the former node device 20\_3, which is stored in the storage portion 11\_1 of the destination terminal 10\_1, and the address of the destination terminal  
10 10\_1 in the storage portion (not shown) of its own device.

The destination terminal 10\_1 moves to the area (not shown) of the latest node device, and the destination node device 20\_4 receives the notification of the addresses of the latest node device and the destination terminal from  
15 the latest node device.

The destination node device 20\_4 (the destination terminal 10\_1 is not located at present in its area) notifies the former node device 20\_3 of the address [ADR5] stored in the storage portion of the addresses of the  
20 latest node device and the destination terminal.

This enables the former node device 20\_3 to know the address of the latest node device having the area where the destination terminal 10\_1 is located.

Also in the present embodiment, the communication  
25 system may further comprise a location registering server for notifying the former node device of an address of the destination node device and the destination terminal based on the address of the former node device registered in a location registering table from a previous location  
30 registration when receiving a location registration request from the destination terminal.

Namely, when the destination terminal 10\_1 has moved to the area 21\_4, the destination node device 20\_4 makes the location registration request of the destination terminal 10\_1 to the location registering server 30\_1.

5       The location registering server 30\_1 knows the address of the former node device 20\_3 having the area where the destination terminal 10\_1 was located from the location registering table 31\_1 before making the location registration in response to the location registration request, and notifies the former node device 20\_3 of the address [ADR6] of the destination node device and the address of the destination terminal.

10       This enables the former node device 20\_3 to know the address [ADR6] of the destination node device 20\_4 even when the destination terminal 10\_1 moves outside of its own area 21\_3.

15       Also in the present embodiment, when receiving the location registration request of the destination terminal during a communication, the location registering server may make no location registration and will notify the node device with which the destination terminal originally started the communication, of the addresses of both the current node device and the destination terminal.

20       Namely, when receiving the location registration request of the destination terminal 10\_1 from the destination node device 20\_4 while the destination terminal 10\_1 is communicating, the location registering server 30\_1 neither makes the location registration nor updates the address of the former node device 20\_3 to the address of the destination node device 20\_4.

25       Thus, even when the destination terminal 10\_1 moves

to the areas of equal to or more than two node devices during the communication, the location registering server 30\_1 notifies the node device 20\_3, with which the destination terminal 10\_1 has started the communication, of the address [ADR6].

Thus, the communication start node device 20\_3 knows the address [ADR6] of the destination node device 20\_4.

Also in the present embodiment, the communication system may further comprise a location registering server, and the destination node device may obtain, from the location registering server, the address of the former node device having the area where the destination terminal was located before making a location registration of the destination terminal when the destination terminal has moved to its own area and to notify the former node device of the addresses of its own device and the destination terminal.

Namely, when the destination terminal 10\_1 has moved to the area 21\_4, the destination node device 20\_4 obtains the address of the destination node device from the location registering server 30\_1 before the location registration of the destination terminal 10\_1. Since it is the node device before the location registration, the address is [ADR5] of the former node device 20\_3.

The destination node device 20\_4 notifies the address [ADR6] of its own device and the address of the destination terminal to the former node device 20\_3 at address [ADR5].

Thus, it becomes possible for the former node device 20\_3 to know the address [ADR6] of the destination node device 20\_4, even when the destination terminal 10\_1 has

moved outside of its own area.

Also in the present embodiment, the communication system may comprise a location registering server which comprises a storage portion for storing the address of the former node device and notifies the former node device of the addresses of a new node device and the destination terminal to which location registrations are made when receiving a location registration request from the destination terminal.

10       Namely, the location registering server 30\_1 stores, in the storage portion (not shown), the address [ADR5] of the former node device 20\_3 having the area where the destination terminal 10\_1 was located.

15       When the destination terminal 10\_1 has moved to the area 21\_4, the destination node device 20\_4 makes the location registration of the destination terminal 10\_1 to the location registering server 30\_1.

20       The location registering server 30\_1 notifies the former node device 20\_3 having the stored address [ADR5] of the address [ADR6] of the new node device (destination node device 20\_4) and the address of the destination terminal.

25       Thus, the destination node device 20\_4 has notified the former node device 20\_3 of the address [ADR6] of the new node device and the address of the destination terminal through the location registering server 30\_1.

Also in the present embodiment, the communication system may comprise a location registering server which comprises a storage portion for storing the address of the former node device, and the destination node device may receive the address of the former node device from the



location registering server when the destination terminal  
has moved to the area of the destination node device, such  
that the destination node may notify the former node device  
of the addresses of its own device and the destination  
5 terminal.

Namely, the location registering server 30\_1 stores,  
in the storage portion (not shown), the address [ADR5] of  
the former node device 20\_3 having the area where the  
destination terminal 10\_1 was located.

10 When the destination terminal 10\_1 has moved to the  
area 21\_4, the destination node device 20\_4 obtains the  
address [ADR5] of the former node device stored in the  
storage portion by inquiring to location registering  
server 30\_1 or by notification from the location  
15 registering server 30\_1 in response to the location  
registration.

The node device 20\_4 directly notifies the node  
device 20\_3 of the address [ADR6] of its own device and  
the address of the destination terminal. Thus, the node  
20 device 20\_3 knows the address [ADR6] of the node device  
having the area where the destination terminal 10\_1 is  
located.

Further, while the destination terminal continues a  
communication the storage portion may store the address  
25 of the original node device where the destination terminal  
started communication, and the destination node device may  
notify the original node device where communication  
started of the addresses of its own device and the  
destination terminal.

30 Namely, the storage portion of the location  
registering server 30\_1 stores the address [ADR5] of the

node device (communication start node device) 20\_3 where the destination terminal 10\_1 started communication.

Thus, the address [ADR6] of the node device 20\_4 and the address of the destination terminal are notified to the node device 20\_3 through either the location registering server 30\_1 or directly from the node device 20\_4.

Thus, even when the destination terminal sequentially moves to other areas during communication, the communication start node device 20\_3 knows the address of the node device having the area where the destination terminal is located at present.

Further in the present embodiment, the storage portion may store all of the addresses of the node devices having the areas where the destination terminal has been located from a communication start of the destination terminal to a present time, and the destination node device may notify all of the former node devices of the addresses of the destination node device and the destination terminal.

Namely, the location registering server 30\_1 stores, in the storage portion, the addresses (including the address of the communication start node device) of all of the former node devices having the areas where the destination terminal 10\_1 has been located from the start of the communication to the present time.

The address of the node device having the area where the destination terminal is located at present and the address of the destination terminal are notified to all of the former node devices through either the location registering server or directly from the node device where

the destination terminal is located at present.

Thus, all of the former node devices having the areas to which the destination terminal has moved during the communication know the address of the node device having  
5 the area where the destination terminal is located at present.

Hereinafter, Method 1 for achieving Object 2 will be described.

In order to achieve the above-mentioned Object 2, a  
10 node device on a receiving side of the present invention composes a communication system with a terminal and a location registering server, the node device notifies a source node device of a received packet of an address of a destination node device having an area where a  
15 destination terminal is located when knowing the address of the destination node device, while otherwise notifies the location registering server whereby the address of the destination node device registered in the location registering server is provided to the source node device,  
20 both when the destination terminal of the packet is not located in its own area.

Fig.3 shows an operation principle of Method 1 for achieving Object 2 which composes the communication system with the terminal and the location registering server. The  
25 arrangement of the communication system is the same as that of the communication system of Fig.1.

In this operation principle, schematically, upon the reception of the inter-node packet 81 as a trigger, the node device 20\_3 on the receiving side notifies the source  
30 node device 20\_2 of the address [ADR6], which is known to its own device 20\_3 or which is registered in the location

registering server 30\_1, of the node device 20\_4, having the area where the destination terminal 10\_1 is located.

Hereinafter, the detailed operation will be described.

- 5        In Fig.3, as the state before the transfer operation of the packet 71, the source node device 20\_2 stores the address [ADR5] of the node device 20\_3 having the area where the destination terminal 10\_1 is located in the location information table 22\_2. The terminal 10\_1 moves
- 10    from the area 21\_3 of the node device 20\_3 to the area 21\_4 of the node device 20\_4 and makes the location registration. The address [ADR6] of the node device 20\_4 is registered in the location registering table 31\_1 of the location registering server 30\_1 made corresponding to the address
- 15    [1.1.1] of the terminal 10\_1.
- Step S1: The user packet 71 addressed to the terminal 10\_1 arrives at the node device 20\_2.
- Step S2: The node device 20\_2 retrieves the location information table 22\_2 to obtain the address [ADR5] of the
- 20    node device 20\_3 having the area where the terminal 10\_1 is located.
- Step S3: The node device 20\_2 transmits the inter-node packet 81 which is the received user packet 71, addressed to the terminal 10\_1 and added with the address [ADR5] of
- 25    the node device 20\_3.
- Step S4: Since the terminal 10\_1 that is the destination of the received packet 81 (packet 71) is not located in the area 21\_3, the node device 20\_3 notifies the source node device 20\_2 of the address [ADR6] of the node device
- 30    20\_4 having the area where the terminal 10\_1 is located when the address [ADR6] is known.

When the address [ADR6] of the destination node device 20\_4 is not known, the node device 20\_3 directly or indirectly notifies the node device 20\_2 of the address [ADR6], registered in the location registering server 30\_1,  
5 of the node device 20\_4 having the area where the terminal 10\_1 is located.

Thus, the source node device knows the destination node device, and even when the destination terminal has moved, it becomes possible to transfer the packet to the  
10 destination node device.

Also, in the present invention the node device on the receiving side may further comprise a storage portion for storing the address of the destination node device, the node device on the receiving side may notify the source  
15 node device of the addresses of the destination node device and the destination terminal by referring to the storage portion when the destination terminal of the received packet is not located in its own area.

Namely, in Fig.3, the node device 20\_3 on the  
20 receiving side stores, in the storage portion (not shown), the address [ADR6] of the destination node device obtained by receiving the address [ADR6] from other devices.

The node device 20\_3 on the receiving side notifies the source node device of the address [ADR6] and the  
25 address of the destination terminal, when the destination terminal of the received inter-node packet is not located in its own area.

Thus, the source node device 20\_2 knows the address of the node device having the area where the destination  
30 terminal 10\_1 is located at present, and even when the destination terminal 10\_1 has moved, it is possible to

transfer the packet to the destination node device.

It is to be noted that the node device 20\_3 can use the Method described in "Method 2 for achieving Object 1" as the Method for storing the address of the destination  
5 node device.

Also, in the present invention the communication system may further comprise a location registering server, and the node device on the receiving side may transfer the received packet to the location registering server and  
10 request the location registering server to notify the source node device of the address of the destination node device and the destination terminal.

Namely, in Fig.3, by transferring the packet 81 to the location registering server 30\_1, the node device 20\_3  
15 on the receiving side requests the location registering server to notify the source node device 20\_2 of the address [ADR6] of the destination node device 20\_4 and the address of the destination terminal.

The location registering server 30\_1 notifies the  
20 source node device 20\_2 of the address [ADR6] of the destination node device 20\_4 and the address of the destination terminal.

Also, in the present invention the communication system may further comprise a location registering server,  
25 and the node device on the receiving side may transmit, to the location registering server, a message for requesting to notify the source node device of the address of the destination node device and the destination terminal.

30 Namely, when the destination terminal 10\_1 of the packet 81 is not located in the area 21\_3, the message for

requesting to notify the source node device 20\_2 of the address [ADR6] of the destination node device and the address of the destination terminal is transmitted to the location registering server 30\_1.

5       The location registering server 30\_1 notifies the source node device 20\_2 of the address [ADR6] and the address of the destination terminal.

Thus the source node device 20\_2 knows the address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located.

10       In further alternative embodiment the communication system may further comprise a location registering server, and the node device on the receiving side may obtain the address of the destination node device from the location registering server to notify the source node device of the address of the destination node device and the destination terminal.

15       Namely, in Fig.3, the node device 20\_3 on the receiving side inquires of the location registering server 30\_1 about the address [ADR6] of the node device having the area where the destination terminal 10\_1 is located, and notifies the source node device 20\_2 of the obtained address [ADR6] and the address of the destination terminal.

20       Thus, the source node device 20\_2 knows the address [ADR6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located at present.

Furthermore, Method 2 for achieving Object 2 will be described.

30       In order to achieve the above-mentioned Object 2, an embodiment of a node device composes a communication

system with a terminal, and the destination node device notifies a source node device of addresses of its own device and the destination terminal based on an address stored in a storage portion provided in at least one of  
5 the terminal and the node device when the destination terminal has moved to another area.

Fig.4 shows an operation principle of the node device according to the present invention which composes the communication system with the terminal and the location  
10 registering server. The arrangement of the communication system is the same as that of Fig.1.

The detailed operation will be described.

It is to be noted that the terminal may generally perform the packet communication with a plurality of  
15 terminals simultaneously. In the following description, the case where the destination terminal 10\_1 receives the packets from two source terminals 10\_3 and 10\_4 will be described. However, in this Method 2, the source terminal may be single.

20 Also in alternative embodiments of Method 2 the location registering server may not be needed. However, the location registering server will be included in the description.

The state before the packet addressed to the  
25 destination terminal 10\_1 is transferred is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

The source node devices (the node device having the area where the source terminal is located) 20\_1 and 20\_2  
30 respectively store, in the location information tables 22\_1 and 22\_2, the address [ADR5] of the node device 20\_3



having the area where the destination terminal 10\_1 is located.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

- 5    Step S2: The node device 20\_4 knows that the terminal 10\_1 has moved to the area 21\_4 by the location registration or the like from the destination terminal 10\_1.

- Step S3: The destination node device 20\_4 notifies the source node devices 20\_1 and 20\_2 of the address [ADR6]  
10    of its own device and the address of the destination terminal directly or indirectly through other devices based on a predetermined address (e.g. the address of the source terminal 10\_4, the source node device 10\_4, or the like) stored in the storage portion (e.g. the storage  
15    portion 11\_1, 23\_3, 32\_1, or the like) of the device (e.g. the terminal, the node device, the location registering server, or the like) in the communication system.

- Step S4: The source node devices 20\_1 and 20\_2 know the address of the node device 20\_4 having the area where the  
20    destination terminal 10\_1 is located at present.

      This enables the source node devices 20\_1 and 20\_2 to directly transfer the packet addressed to the terminal 10\_1 to the node device 20\_4 having the area where the terminal 10\_1 is located.

- 25       Also, in the present invention the destination terminal may comprise a storage portion for storing an address of the source node device(s), and the destination node device may receive the address from the destination terminal to notify the source node device(s) of the address  
30    of its own device.

      Namely, in Fig.4, the storage portion 11\_1 of the

destination terminal 10\_1 stores the addresses [ADR3] and [ADR4] of the source node devices 20\_1 and 20\_2 having the areas where the source terminals 10\_3 and 10\_4 are located.

When the destination terminal 10\_1 has moved to the  
5 area 21\_4, the addresses of the source node devices stored in the storage portion 11\_1 are notified from the destination terminal 10\_1 (or received after an inquiry by the destination terminal), so that the destination node device 20\_4 transmits the addresses of its own device and  
10 the destination terminal to the source node devices 20\_1 and 20\_2 of the addresses.

Thus, the source node devices 20\_1 and 20\_2 know the address of the destination node device 20\_4 and stop continuing to transmit the packet to the former node device  
15 20\_3 having the area where the destination terminal 10\_1 is not located.

Also, in the present invention the communication system may further comprise a location registering server, the destination terminal may comprise a storage portion  
20 for storing an address of a source terminal, and the destination node device may transmit, to the location registering server, a message including the address received from the destination terminal as well as the addresses of its own device and the destination terminal,  
25 and may notify the source node(s) device of the address of its own device.

Namely, in Fig.4, the storage portion 11\_1 of the destination terminal 10\_1 stores the addresses [2.1.1] and [2.2.1] of the source terminals 10\_3 and 10\_4. When the  
30 destination terminal 10\_1 has moved to the area 21\_4, the node device 20\_4 receives the addresses.

The node device 20\_4 transmits the message including the addresses and the address [ADR6] of its own device to the location registering server 30\_2, and requests to notify the source node devices 20\_1 and 20\_2 of the address  
5 [ADR6] of its own device and the address of the destination terminal.

The location registering server 30\_2 notifies the source node devices 20\_1 and 20\_2 of the address [ADR6] of the destination node device and the address of the  
10 destination terminal.

Thus, it becomes possible for the source node devices 20\_1 and 20\_2 to know the address [ADR6] of the destination node device.

It is to be noted that the Method by which the node  
15 device 20\_4 selects the location registering server 30\_2 between the location registering servers 30\_1 and 30\_2 will be described later.

Also, in the present invention the communication system may further comprise a location registering server,  
20 and the destination node device may comprise a storage portion for storing an address of the source node device, and may receive, from a new destination node device having an area to which the destination terminal has moved, addresses of the new destination node device and the  
25 destination terminal through the location registering server to notify the source node device of the address of the new destination node device when the destination terminal has moved to an area outside the area of the destination node device.

30 Namely, in Fig.4, before the destination terminal moves, the destination node device 20\_3 stores the

addresses [ADR3] and [ADR4] of the node devices 20\_1 and 20\_2 (hereinafter occasionally referred to as source node device) having the area where the source destination terminal is located in the storage portion 23\_3.

5       When the destination terminal 10\_1 has moved from the area 21\_3 to the area 21\_4 of the node device 20\_4, the new destination node device 20\_4 transmits the address [ADR6] of its own device and the address of the destination terminal to the node device 20\_3 through the location  
10   registering server 30\_1.

      The now former destination node device 20\_3 (at this time, the destination terminal 10\_1 has already moved, and is not located in the area of the node device 20\_3) notifies the source node devices 20\_1 and 20\_2 of the addresses  
15   stored in the storage portion 23\_3 of the received address [ADR6] and the address of the destination terminal.

      Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device 20\_4 having the area to which the destination terminal 10\_1 has moved.

20       Also, in the present invention the destination terminal may comprise a storage portion for storing an address of the node device having the area where the destination terminal was located, and the node device may further comprise a storage portion for storing an address  
25   of the source node device, and may receive, from a destination node device of the destination terminal, addresses of the destination node device and the destination terminal to notify the source node device of the address of the destination node device when the  
30   destination terminal has moved to an area outside that of the node device .

Namely, in Fig.4, before the destination terminal moves, the destination node device 20\_3 stores the addresses [ADR3] and [ADR4] of the source node devices 20\_1 and 20\_2 in the storage portion 23\_3.

5        When the destination terminal 10\_1 has moved from the area 21\_3 to the area 21\_4 of the node device 20\_4, the destination node device 20\_4 directly transmits the address [ADR6] of its own device and the address of the destination terminal to the node device 20\_3 based on the  
10       address of the former destination node device of the storage portion 11\_1.

      The node device 20\_3 notifies the source node devices 20\_1 and 20\_2 of the addresses [ADR3] and [ADR4] stored in the storage portion 23\_3 of the received address [ADR6]  
15       of the node device 20\_4 and the address of the destination terminal.

      Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device 20\_4 of the destination terminal 10\_1.

20       Also, in the present invention the communication system may further comprise a location registering server, the destination terminal may comprise a storage portion for storing an address of the node device having the area where the destination terminal was located, and the node  
25       device may further comprise a storage portion for storing an address of a source terminal, the node device may transmit a message to the location registering server when the destination terminal has moved outside its area. The message including (1) an address of a destination node  
30       device, the address being received from the destination node device of the destination terminal and is based on

the address stored by the storage portion of the destination terminal; (2) the address of the destination terminal; and (3) the address of the stored source terminal and the node device may request the location registering  
5 server to notify the source node device of the addresses of the destination node device and the destination terminal.

Namely, in Fig.4, before moving, the destination terminal 10\_1 stores the address of the node device having  
10 the area where the destination terminal 10\_1 is located in the storage portion 11\_1; while the destination node device 20\_3 stores the address of the source terminal in the storage portion 23\_3.

When the destination terminal 10\_1 has moved outside  
15 of the area 21\_3 of the node device 20\_3, the new destination node device 20\_4 notifies the former node device 20\_3, whose address is stored in the storage portion 11\_1 of the destination terminal 10\_1 before the destination terminal moves, of the address [ADR6] of its  
20 own device and the address of the destination terminal.

The former node device (former destination node device) 20\_3 sends a message including the source terminal address stored in the storage portion 23\_3, the received address [ADR6] of the new destination node device, and the  
25 destination terminal address to the location registering server 30\_2 to request the location registering server 30\_2 to notify the source node devices 20\_1 and 20\_2 of the address [ADR6] of the destination node device and the address of the destination terminal.

30 Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device 20\_4.

Also, in the present invention the communication system may further comprise a location registering server, the location registering server may further comprise a storage portion for storing an address of the source node device, the destination node device may transmit, to the location registering server, a message including the addresses of its own device and the destination terminal when the destination terminal has moved to its own area, and may request the location registering server to notify the source node device of the addresses of its own device and the destination terminal.

Namely, the storage portion 32\_1 of the location registering server 30\_1 stores the addresses [ADR3] and [ADR4] of the source node devices.

When the destination terminal 10\_1 has moved to the area 21\_4 of the destination node device 20\_4, the device 20\_4 sends the message (e.g. location registration request) including the address [ADR6] of its own device and the address of the destination terminal to the location registering server 30\_1, and requests the location registering server to notify the source node devices 20\_1 and 20\_2 of the address [ADR6] of its own device and the address of the destination terminal by using this message.

The location registering server 30\_1 notifies the source node devices 20\_1 and 20\_2 of the address [ADR6] of the destination node device and the address of the destination terminal based on the addresses stored in the storage portion 32\_1.

Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device, and hereafter the packet addressed to the destination terminal

10\_1 is directly transferred to the destination node device 20\_4.

Also, in the present invention the communication system may further comprise a location registering server, the location registering server may comprise a storage portion for storing an address of the source node device, and the destination node device may inquire of the location registering server about the address of the source node device when the destination terminal has moved to its own area, and may directly notify the source node device of the addresses of its own device and the destination terminal based on its inquiry to the location registering server.

Namely, in Fig.4, the location registering server 30\_1 stores the addresses [ADR3] and [ADR4] of the source node devices 20\_1 and 20\_2 in the storage portion 32\_1.

When the destination terminal 10\_1 has moved to the area 21\_4, the destination node device 20\_4 inquires about the addresses of the node devices (source node devices) having the areas where the source terminals 10\_3 and 10\_4, which are transmitting the packets to the destination terminal, are located.

The location registering server 30\_1 retrieves from the storage portion 32\_1 to send back the addresses [ADR3] and [ADR4] of the source node devices. The node device 20\_4 directly transmits the address [ADR6] of its own device and the address of the destination terminal to the source node devices 20\_1 and 20\_2.

Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the node device having the area where the destination terminal 10\_1 is located.



Also, in the present invention the communication system may further comprise a location registering server, the location registering server may further comprise a storage portion for storing an address of a source terminal  
5 corresponding to the destination terminal, and the destination node device may transmit, to the location registering server, a message including the addresses of its own device and the destination terminal when the destination terminal has moved to its own area, and may  
10 request the location registering server to notify the source node device of the addresses of its own device and the destination terminal.

Namely, in Fig.4, the storage portion 32\_1 of the location registering server 30\_1 stores the addresses of  
15 the source terminals 10\_3 and 10\_4.

When the destination terminal 10\_1 has moved to the area 21\_4, the destination node device 20\_4 sends the message (e.g. location registration request) including the address [ADR6] of its own device and the address of  
20 the destination terminal to the location registering server 30\_1, and requests the location registering server to notify the source node devices 20\_1 and 20\_2 of the address [ADR6] of its own device and the address of the destination terminal by using this message.

25 The location registering server 30\_1 notifies the source node devices 20\_1 and 20\_2 of the address [ADR6] of the destination node device and the address of the destination terminal based on the address stored in the storage portion 32\_1.

30 Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device and

hereafter the packet addressed to the destination terminal 10\_1 is directly transferred to its destination node device 20\_4.

Also, in the present invention the communication  
5 system may further comprise a location registering server which comprises a storage portion for storing an address of a source terminal corresponding to the destination terminal, and when the destination terminal has moved to an area of the destination node device, the destination  
10 node device may receive from the location registering server both the address of the source terminal and an address of a source node device having the area where the source terminal of the address is located, and directly transmit, to the source node device, the addresses of its  
15 own device and the destination terminal.

Namely, in Fig.4, the storage portion 32\_1 of the location registering server 30\_1 stores the addresses of the source terminals 10\_3 and 10\_4 corresponding to the destination terminal 10\_1.

20 When the destination terminal 10\_1 has moved to the area 21\_4, the node device 20\_4 inquires of the location registering server 30\_1 about the addresses of the source terminals 10\_3 and 10\_4.

The location registering server 30\_1 sends back the  
25 addresses stored in the storage portion 32\_1 to the node device 20\_4.

The node device 20\_4 inquires of the location registering server 30\_2 about the addresses of the source node devices having the areas where the source terminals  
30 of the received addresses are located. The location registering server 30\_2 sends back the addresses [ADR3]

and [ADR4] of the source node devices to the node device 20\_4.

Based on the addresses [ADR3] and [ADR4], the node device 20\_4 directly transmits the address [ADR6] of its own device and the address of the destination terminal to the source node devices 20\_1 and 20\_2.

Thus, the source node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node device and hereafter the packet addressed to the destination terminal 10\_1 is directly transferred to the destination node device 20\_4.

Also, in the present invention when a location registering table of a location registering server does not contain a location registration of a source terminal stored in its storage portion, the location registering server may request another location registering server in which the source terminal is registered to notify the source node device of the addresses of the destination node device and the destination terminal.

Namely, in Fig.4, when the location registration of the source terminals 10\_3 and 10\_4 of the addresses stored in the storage portion 32\_1 is not made to the location registering table 31\_1 of its own device, the location registering server 30\_1 requests another location registering server 30\_2, where the location registration is made, to notify the address [ADR6] of the destination node device and the address of the destination terminal.

The location registering server 30\_2 notifies the node devices 20\_1 and 20\_2 having the areas where the source terminals are located of the address [ADR6] of the destination node device and the address of the destination

terminal.

Thus, the node devices 20\_1 and 20\_2 know the address [ADR6] of the destination node address and hereafter the packet addressed to the destination terminal 10\_1 is

5 directly transferred to the destination node device 20\_4.

Also, in the present invention a storage portion of the terminal may be included in an adapter connected to the terminal.

10 Namely, the adapter connected to the terminal can be provided with the storage portion. This enables the storage portion to be separated from the terminal when it is not required, thereby reducing the cost and weight of the terminal.

Also, in the present invention a packet  
15 transmitted/received between the devices may designate to a destination device at least one of a necessity of transferring its own packet, a transfer destination, a necessity of a response message, and a response destination.

20 Namely, in the communication system, the packet transmitted/ received between the node devices and the location registering servers (when the communication system has the location registering servers) can designate, to the destination device, at least one of the followings;

25 ① Designation of whether or not to transfer the received packet,

② Designation of a transfer destination device in case of "transfer" in the above ①,

30 ③ Designation of whether or not the response message is necessary,

④ Designation of the destination of the response message in case of "necessary" in the above ③.

Also, in the present invention a message transmitted/received between the devices may designate,  
5 to a destination device, at least a necessity of a response message and a response destination.

Namely, in the communication system, the message transmitted/received between the node devices and the location registering servers (when the communication  
10 system has the location registering servers) can designate to the destination device, ① designation of whether or not the response message is necessary and ② designation of the destination of the response message in case of "necessary".

Also, in the present invention the communication system may comprise a plurality of location registering servers, and the node device may comprise a server  
15 retrieval table which makes the destination terminal corresponding to an address of the location registering server where a location registration is made to the  
20 destination terminal.

Thus, even when the communication system is provided with a plurality of location registering servers, it becomes possible for the node device to know the location  
25 registering server to which the location registration should be made for the terminal located in the area, and the location registering server of which the address of the node device having the area where the source or the destination terminal is located is inquired.

Also, in the present invention the device may be

connected with a router to compose the communication system.

Also, in the present invention the device may be connected with an ATM-SW to compose the communication system.

Also, in the present invention at least one of the terminals may comprise a fixed terminal, and at least one of the node devices may comprise a node device for a fixed communication network.

Namely, at least one of the node devices may be the node device for the fixed communication network connected to the fixed terminal.

#### Brief Description of the Drawings

Fig.1 is a block diagram showing an operation principle (1) of a node device according to the present invention;

Fig.2 is a block diagram showing an operation principle (2) of a node device according to the present invention;

Fig.3 is a block diagram showing an operation principle (3) of a node device according to the present invention;

Fig.4 is a block diagram showing an operation principle (4) of a node device according to the present invention;

Fig.5 is a block diagram showing an embodiment (1) of a node device according to the present invention;

Fig.6 is a block diagram showing an embodiment (2) of a node device according to the present invention;

Fig.7 is a block diagram showing an embodiment (3)

of a node device according to the present invention;

Fig.8 is a diagram showing a format example of a packet used in the embodiment (3) of a node device according to the present invention;

5        Fig.9 is a block diagram showing an embodiment (4) of a node device according to the present invention;

Fig.10 is a block diagram showing an embodiment (5) of a node device according to the present invention;

10       Fig.11 is a block diagram showing an embodiment (6) of a node device according to the present invention;

Fig.12 is a block diagram showing an embodiment (7) of a node device according to the present invention;

Fig.13 is a block diagram showing an embodiment (8) of a node device according to the present invention;

15       Fig.14 is a block diagram showing an embodiment (9) of a node device according to the present invention;

Fig.15 is a block diagram showing an embodiment (10) of a node device according to the present invention;

20       Fig.16 is a block diagram showing an embodiment (11) of a node device according to the present invention;

Fig.17 is a block diagram showing an embodiment (12) of a node device according to the present invention;

Fig.18 is a block diagram showing an embodiment (13) of a node device according to the present invention;

25       Fig.19 is a block diagram showing an embodiment (14) of a node device according to the present invention;

Fig.20 is a block diagram showing an embodiment (15) of a node device according to the present invention;

30       Fig.21 is a block diagram showing an embodiment (16) of a node device according to the present invention;

Fig.22 is a block diagram showing an embodiment (17)

of a node device according to the present invention;

Fig.23 is a block diagram showing an embodiment (18)  
of a node device according to the present invention;

Fig.24 is a block diagram showing an embodiment (19)  
5 of a node device according to the present invention;

Fig.25 is a block diagram showing an embodiment (20)  
of a node device according to the present invention;

Fig.26 is a block diagram showing an embodiment (21)  
of a node device according to the present invention;

10 Fig.27 is a block diagram showing an embodiment (22)  
of a node device according to the present invention;

Fig.28 is a block diagram showing an embodiment (23)  
of a node device according to the present invention;

Fig.29 is a diagram showing a format example of a  
15 packet used in the embodiment (23) of a node device  
according to the present invention;

Fig.30 is a block diagram showing an embodiment (24)  
of a node device according to the present invention;

Fig.31 is a block diagram showing an embodiment (25)  
20 of a node device according to the present invention;

Fig.32 is a block diagram showing an arrangement of  
a mobile packet communication system composed of a general  
node device;

Fig.33 is a block diagram showing an operation  
25 example (1) of a packet transfer in a mobile packet  
communication system; and

Fig.34 is a block diagram showing an operation  
example (2) of a packet transfer in a mobile packet  
communication system.

30 Throughout the figures, like reference numerals  
indicate like or corresponding components.



### Description of the Embodiments

Hereinafter, embodiments (1)-(24) of a communication system composed of node devices according to the present invention will be described. In the embodiments (1)-(23), the node devices compose sub-communication systems with terminals and location registering servers. These sub-communication systems are connected with routers to compose a general IP (Internet Protocol) communication system, or a router network.

In the embodiment (24), an arrangement of a communication system applied to an ATM network is shown. It is to be noted that only required devices are illustrated in each of the sub-communication systems while other devices are omitted. It is further noted that the network architecture as shown in the drawings is not a requirement. For example a shown ring type network is only for example purposes.

Usually, when a terminal moves to an area of a node device, a location registration to a location registering server is made, but this usual location registration is not illustrated.

However, depending on the embodiments, there are cases where this usual location registration is illustrated. In such cases, the location registration is shown by an arrow with a dotted line.

It is to be noted that the node devices of the embodiments (1)-(24) of the present invention can be connected with either a mobile network (a wireless network or the like) or a fixed network (a cable network or the like).

The movement of a terminal leads to a connection change of a fixed terminal (station device) connected to a fixed network node device to another fixed network node device, or to a movement from an area of a mobile network node device to an area of another mobile network node device.

Moreover, it is also possible for a terminal, for example, which has a function of being connectable to both a mobile network and a fixed network to move between the mobile network node device and the fixed network node device. Further a node device may maintain a periodic communication between the node device and the terminal. If the node device discovers the terminal is no longer communicating it may consider the terminal to have "disappeared".

In the embodiments (1)-(24), these movements are merely described as "a destination terminal moves from an area of a node device to an area of another node device".

(i) Embodiments of Method 1 for achieving Object 1  
(embodiment (1) of Fig.5 to embodiment (3) of Fig.7 and embodiment (4) of Fig.9)

These embodiments are examples for achieving Object 1 (to reduce the packet loss which occurs by the destination terminal movement to the area of another node device) based on Method 1 (to transfer the packet to the destination node device directly or indirectly through other devices based on the location information of the destination terminal in the node device or the location registering server).

Fig.5 shows the embodiment (1) of the node device

according to the present invention which composes the communication system. In the arrangement of this communication system, the general IP (Internet Protocol) network or the router network is applied to the communication system between the location registering servers 30\_1, 30\_2 and the node devices 20\_1-20\_4.

Namely, the location registering servers 30\_1, 30\_2 and the node devices 20\_1-20\_4 are connected respectively with routers 50\_1-50\_6 to compose the IP network. Many variations of a connection of each router are considered, for example a mesh type connection, a ring type connection.

IP addresses [133.1.1]-[133.1.6] are respectively assigned to the location registering servers 30\_1, 30\_2 and the node devices 20\_1-20\_4.

Hereinafter, operations of this embodiment will be described in the order of processing steps.

The state of the communication system before the packet transfer is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

The source node device 20\_2 stores the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the network through the node device 20\_4.

Step S3: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the

address [1.1.1] of the terminal 10\_1.

Step S4: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

5 Step S5: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Step S6: The user packet 71 addressed to the terminal 10\_1  
10 arrives at the node device 20\_2.

Step S7: The node device 20\_2 retrieves the location information table 22\_2 to obtain the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 was located.

15 Step S8: The node device 20\_2 adds the address [133.1.5] of the node device 20\_3 to the received packet 71 addressed to the terminal 10\_1 to transfer the packet as the inter-node packet 81.

Step S9: When the destination terminal 10\_1 is not located  
20 in the area 21\_3, the node device 20\_3 which has received the packet 81 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

25 Step S10: The node device 20\_3 transfers the packet 82, which has a destination address of the packet 81 rewritten to [133.1.1], to the location registering server 30\_1.

Step S11: The location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address  
30 [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located.

Step S12: The location registering server 30\_1 transfers the packet 83, which has the destination address of the received packet 82 rewritten to [133.1.6], to the node device 20\_4.

5        Thus, even in case the terminal 10\_1 moves from the area 21\_3 of the node device 20\_3 to the area 21\_4 of the node device 20\_4 while the communication is continuing, the packet 71 is transferred to the destination terminal 10\_1 through the node device 20\_3, the location  
10    registering server 30\_1, and the node device 20\_4.

      It is to be noted that at steps S3 and S9, the node devices 20\_4 and 20\_3 respectively retrieve the server retrieval table 40 to obtain the address of the location registering server 30\_1 corresponding to the address of  
15    the terminal 10\_1. However, when the communication system is provided with only one location registering server, the node device 20\_4 is not required to be provided with the server retrieval table 40.

      Namely, in case the location registration  
20    information is dispersedly registered in a plurality of location registering servers, the node device and the location registering servers of the embodiment (22) which will be described later are required to be provided with the server retrieval table 40.

25        Moreover, in case the inter-node packet 82 is transferred to the location registration server 30\_1 by steps S6-S10 before the address of the node device 20\_4 having the area where the terminal 10\_1 is located in the location registering table 31\_1 is updated to [133.1.6]  
30    at step S5 in this embodiment, there is a possibility that a loop is generated between the node device 20\_3 and the

location registration server 30\_1 since the location registering server 30\_1 transfers the inter-node packet to [133.1.5] which is the address before the update.

Measures therefore are as follows:

5 (1) A survival time (Time To Live) field included in a header of the IP packet is used, and the packet is discarded when the number of the routers passed through becomes equal to or more than a predetermined value.

10 (2) The location registering server 30\_1 compares a source address of the inter-node packet 82 with an address of the node device having the area where the destination terminal of the user packet 71 is located registered in the location registering table 31\_1. If they have the same address, the location registration server 30\_1 discards  
15 the packet by judging that the loop will be generated. Also, by using the survival time (Time To Live) field in the same way as (1) above, when the number of the routers passed through is equal to or less than the predetermined value, the location registration server 30\_1 waits until the  
20 destination terminal has its location registered, while otherwise discarding the packet.

Fig.6 shows the embodiment (2) of the node device according to the present invention which composes the communication system. The arrangement of this  
25 communication system is the same as that of the embodiment (1) in Fig.5. However, this embodiment (2) is different from the embodiment (1) in that the packet is transmitted through the source node device 20\_2 when the packet is transferred from the node device 20\_3 on the receiving side  
30 to the location registering server 30\_1.

Hereinafter, steps after the state of step S8 in the

embodiment (1) where the packet 81 has been transmitted from the node device 20\_2 to the node device 20\_3 will be described.

5     Step S9: When the terminal 10\_1 is not located in the area 21\_3, the node device 20\_3 sends back, to the node device 20\_2, the inter-node packet 82, which has the destination address of the received packet 81 (see Fig.5) rewritten to [133.1.4] of the source node device 20\_2.

10    Step S10: The node device 20\_2 retrieves the address of the node device having the area where the terminal 10\_1 is located from the location information table 22\_2 to obtain [133.1.5]. Since this address corresponds with the source address of the packet 82, i.e. its own device address [133.1.5], it is judged that the terminal 10\_1 is  
15    not located in the area of the node device 20\_3.

Step S11: Therefore, the node device 20\_2 retrieves the address of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1 from the server retrieval table 40 to obtain [133.1.1].

20    Step S12: The node device 20\_2 transfers the inter-node packet 83, which has the destination address of the received packet 82 rewritten to [133.1.1], to the location registering server 30\_1.

25    Hereafter, the operations of steps S11 and S12 of the embodiment (1) shown in Fig.5 are performed.

      Thus, the packet 71 transmitted from the terminal 10\_4 is transferred to the node device 20\_4 having the area to which the destination terminal has moved as the inter-node packet through the node device 20\_2, the node  
30    device 20\_3, the node device 20\_2, and the location registering server 30\_1 without being discarded.

It is to be noted that as a varied example of this embodiment (2), after step S11, the node device 20\_2 may inquire of the location registering server 30\_1 about the address of the destination node device to transfer the packet 82 directly to the node device 20\_4.

Fig.7 shows the embodiment (3) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is the same as that of the embodiment (2) in Fig.6. However, this embodiment (3) is different from the embodiment (2) in that when the node device 20\_3 on the receiving side sends back the received packet 81 (see Fig.5) to the source node device 20\_2, the packet is sent back through the location registering server corresponding to the source terminal instead of being sent back directly to the node device 20\_2.

Hereinafter, steps after the state of step S8 in the embodiment (1) where the packet 81 has been transmitted from the node device 20\_2 to the node device 20\_3 will be described.

Step S9: When the terminal 10\_1 is not located in the area 21\_3, the node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.2.1] of the source terminal 10\_4.

Step S10: The node device 20\_3 transfers the inter-node packet 82, which has the destination address of the received packet 81 rewritten to [133.1.2], to the location registering server 30\_2.

The Method for indicating that the packet 82 is a returned packet at this time will be described later



referring to Fig.8.

Step S11: The location registering server 30\_2 retrieves the location registering table 31\_2 to obtain the address [133.1.4] of the node device 20\_2 having the area where  
5 the terminal 10\_4 is located.

Step S12: The location registering server 30\_2 transfers the inter-node packet 83, which has the destination address of the received packet 82 rewritten to [133.1.4], to the node device 20\_2.

10 Hereafter, the operations of steps S10-S12 of the embodiment (2) shown in Fig.6 and steps S11 and S12 of the embodiment (1) shown in Fig.5 are performed.

Thus, the packet 71 is transmitted to the destination terminal 10\_1 through the node devices 20\_2, 20\_3, the  
15 server 30\_2, the node device 20\_2, the server 30\_1, and the node device 20\_4.

Fig.8 shows an embodiment of the inter-node packet 82 at step S10 of the embodiment (3) shown in Fig.7. This packet 82 is sent back from the node device 20\_3 on the  
20 receiving side to the source node device 20\_2 as the packet 83 through the location registering server 30\_2 corresponding to the source terminal 10\_4.

The packet 82 is composed of a destination address field 91, a source address field 92, and a message packet  
25 field 90.

The address [133.1.2] of the location registering server 30\_2 which is the destination of the packet 82 and the address [133.1.5] of the source node device 20\_3 are respectively set in the fields 91 and 92.

30 The field 90 is composed of a message destination address field 93, a message source address field 94, a

message information field 95, and a user packet field 71.

The address [133.1.2] of the location registering server 30\_2 which is the destination of the message and the address [133.1.5] of the node device 20\_3 which is the  
5 source of the message are respectively set in the fields 93 and 94.

The field 95 is composed of "Existence of user packet 71", "Message information field length", and "Message classification".

10 The field 95 of the packet 82 at step S10 presents "Existence of user packet 71"="Exist", and "Message classification"="Reply to source node device". The user packet 71 is inserted into the field 71.

The location registering server 30\_2 which has  
15 received the packet 82 reads contents of the message information field 95 and recognizes that the classification of this message packet is "Reply to source node device".

Then, the location registration server 30\_2  
20 retrieves the location registering table 31\_2 at step S11 of the embodiment (3) in Fig.7 to obtain the address [133.1.4] of the node device 20\_2 having the area where the terminal 10\_4 of the address [2.2.1] is located by referring to a source address 97 of the user packet 71.

25 Fig.9 shows the embodiment (4) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is the same as that of the embodiment (1) in Fig.5.

30 The embodiment (4) shows operations following step S8 of the embodiment (1) shown in Fig.5. Namely, it shows

the case where the node device 20\_3 on the receiving side,  
after receiving the inter-node packet 81 (see Fig.5),  
obtains the address of the node device having the area  
where the terminal 10\_1 is located from the location  
5 registering server 30\_1 to transfer the packet to the  
destination node device 20\_4.

Hereinafter, detailed operations after step S8 of the  
embodiment (1) will be described.

Step S9: When the terminal 10\_1 is not located in the area  
10 21\_3, the node device 20\_3 retrieves the server retrieval  
table 40 to obtain the address [133.1.1] of the location  
registering server 30\_1 corresponding to the address  
[1.1.1] of the terminal 10\_1.

Step S10: The node device 20\_3 transmits, to the location  
15 registering server 30\_1, a message inquiring the address  
of the node device having the area where the terminal 10\_1  
is located.

Steps S11 and S12: The location registering server 30\_1  
retrieves the address [133.1.6] of the node device 20\_4  
20 having the area where the terminal 10\_1 is located by  
referring to the location registering table 31\_1 to notify  
the same to the node device 20\_3.

Step S13: The node device 20\_3 transfers the inter-node  
packet 82, which has the destination address of the  
25 received packet 81 rewritten to [133.1.6], to the node  
device 20\_4.

Thus, it becomes possible for the node device 20\_3,  
even in case the destination terminal 10\_1 is not located  
in the area of the node device 20\_3, to transfer the  
30 received packet 81 to the node device 20\_4 having the area  
where the terminal 10\_1 is located.

(ii) Embodiments of Method 2 for achieving Object 1  
(embodiment (5) of Fig.10-embodiment (11) of Fig.16)

These embodiments achieve Object 1 (to reduce the  
5 packet loss which occurs by the destination terminal  
movement to the area of another node device) based on  
Method 2 (to obtain directly or indirectly the address of  
the former node device having the area where the  
destination terminal has been located to notify its own  
10 device address to the former node device directly or  
through other devices when the destination terminal has  
moved to its own area).

Fig.10 shows the embodiment (5) of the node device  
according to the present invention which composes the  
15 communication system. The arrangement of this  
communication system differs from the embodiment (1) in  
Fig.5 only in that the terminal 10\_1 is provided with a  
storage portion, for example a cache 11\_1 for storing the  
address of the node device 20\_3 having the area where the  
20 terminal 10\_1 was located before the movement.

It is to be noted that the location information table  
22\_3 omitted in Fig.5 is shown in the node device 20\_3 in  
Fig.10.

Also, it is possible that not the terminal 10\_1 but  
25 an adapter is provided with the cache 11\_1 so that the  
adapter is connected to the terminal 10\_1 when necessary.

In this embodiment (5), schematically, the  
destination terminal 10\_1 stores the address of the former  
node device in the cache 11\_1 to notify the address of a  
30 latest node device to the former node device every time  
it moves to the latest node device.

Hereinafter, detailed operations of the embodiment (5) will be described.

A state before the transmission of the packet 71 by the source terminal 10\_4 is that the terminal 10\_1 is  
5 located in the area 21\_3 of the node device 20\_3 and the source node device 20\_2 stores the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.  
Step S1: The terminal 10\_1 moves to the area 21\_4 of the  
10 node device 20\_4.  
Step S2: The terminal 10\_1 stores the address [133.1.5] of the former node device 20\_3 in the cache 11\_1.  
Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the node device  
15 20\_4 of the address [133.1.5] of the former node device 20\_3.  
Step S4: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the  
20 address [1.1.1] of the terminal 10\_1.  
Step S5: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.  
Step S6: The node device 20\_4 notifies its own device  
25 address [133.1.6] and the address of the destination terminal to the node device 20\_3.  
Step S7: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 (address [1.1.1]) is located in the location  
30 registering table 31\_1 to [133.1.6].  
Step S8: The node device 20\_3 adds, to the location

information table 22\_3 for "transferring inter-node packets", the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of its destination node device 20\_4.

5     Step S9: The terminal 10\_4 transmits the user packet 71 addressed to the terminal 10\_1.

10    Step S10: The node device 20\_2 retrieves the address [133.1.5] of the node device 20\_3 having the area where the destination terminal 10\_1 of the received packet 71 was located from the location information table 22\_2 for "transferring user packets".

15    Step S11: The node device 20\_2 adds the address [133.1.5] of the node device 20\_3 to the received packet 71 addressed to the terminal 10\_1 and transfers the same as the inter-node packet 81.

20    Step S12: Since the destination terminal 10\_1 is not located in the area 21\_3, the node device 20\_3 refers to the location information table 22\_3 to retrieve the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located from its address [1.1.1] included in the packet 81.

25    Step S13: The node device 20\_3 transfers the inter-node packet 82, which has the destination address of the received packet 81 rewritten to [133.1.6], to the node device 20\_4.

      Hereafter, the packet 71 included in the packet 82 is delivered to the destination terminal 10\_1 through the node device 20\_4.

      It is to be noted that as mentioned above, the location information table 22\_3 is a table for recognizing the address of the node device to which the packet should be transferred by referring to the table when the node

device on the receiving side receives the inter-node packet and the destination terminal is not located in its own device.

On the other hand, the location information table 22\_2 is a conventional table for the source node device to refer to the address of the node device which is the destination of the user packet received from the source terminal.

If indicating both of the addresses of the destination terminal and the destination node device, the table 22\_3 can be used also as the location information table (not shown) included in the node device 20\_3 for transferring user packets. However, the retrieval time gets long when the table is used for both.

In the following embodiments, description will be made supposing that the location information table is used both for transferring inter-node packets and transferring user packets.

Fig.11 shows the embodiment (6) of the node device according to the present invention which composes the communication system. In the arrangement of this communication system, a router 50\_7 is connected to the communication system of the embodiment (5) in Fig.10. A node device 20\_5 is further connected to communication system through the router 50\_7. An address [133.1.7] is assigned to the node device 20\_5 which has an area 21\_5.

In this embodiment (6), schematically, the destination terminal 10\_1 stores the address [133.1.5] of the communication start node device 20\_3 in the cache 11\_1 and notifies the communication start node device 20\_3 of the address of the latest node device every time it moves

to the area of the latest node device.

Hereinafter, detailed operations of the packet transfer of the embodiment (6) will be described.

As a state before the packet transfer operation, the  
5 terminal 10\_1 is located in the area 21\_3 of the node device  
20\_3 with which it has started the communication and it  
is supposed that the source node device 20\_2 stores the  
address [133.1.5] of the node device 20\_3 having the area  
where the terminal 10\_1 is located in the location  
10 information table 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the  
node device 20\_4.

Step S2: The terminal 10\_1 stores the address [133.1.5]  
of the communication start node device 20\_3 in the cache  
15 11\_1.

Step S3: The terminal 10\_1 makes the location registration  
to the network. At this time, it notifies the address  
[133.1.5] of the communication start node device 20\_3.

Step S4: The node device 20\_4 notifies its own device  
20 address [133.1.6] and the address of the destination  
terminal to the communication start node device 20\_3.

Step S5: The node device 20\_3 adds the address of the  
terminal 10\_1 and the address [133.1.6] of its destination  
node device to the location information table 22\_3.

25 Step S6: The terminal 10\_1 moves to the area 21\_5 of the  
node device 20\_5.

Step S7: The terminal 10\_1 maintains the address [133.1.5]  
of the communication start node device 20\_3 in the cache  
11\_1.

30 Step S8: The terminal 10\_1 notifies the address [133.1.5]  
of the communication start node device 20\_3 to the network.



Step S9: The node device 20\_5 notifies its own device address [133.1.7] and the destination terminal address to the communication start node device 20\_3.

Step S10: The node device 20\_3 updates the address of the  
5 node device having the area where the terminal 10\_1 is located in the location information table 22\_3 to [133.1.7].

Steps S11-S13: The user packet 71 addressed to the terminal 10\_1 from the terminal 10\_4 is included in the inter-node  
10 packet 81 to be transferred to the node device 20\_3.

Step S14: The node device 20\_3 retrieves the location information table 22\_3 to obtain the address [133.1.7] of the node device 20\_5 having the area where the terminal 10\_1 is located.

Step S15: The node device 20\_3 transfers the inter-node  
15 packet 82, which has the destination address of the received packet 81 rewritten to [133.1.7], to the node device 20\_5.

Thus, for example, it becomes possible for the node  
20 device 20\_3 to transfer the packet addressed to the terminal 10\_1, which has moved out of its own area during the communication, to the node device 20\_5 having the area where the terminal 10\_1 is located. The packet can be transferred to the node device having the area where the  
25 terminal 10\_1 is located at present in the same way even if the terminal 10\_1 sequentially moves to other areas.

Fig.12 shows the embodiment (7) of the node device according to the present invention which composes the communication system. The arrangement of this  
30 communication system is the same as that of the embodiment (6) shown in Fig.11. However, the location information

table 22\_4 and the server retrieval table 40 which are not shown in Fig.11 are illustrated.

Schematically, in the embodiment (6), the destination terminal 10\_1 notifies only the communication start node device 20\_3 of the addresses of the latest node device and the destination terminal every time it moves to the area of the latest node device. However, in this embodiment (7), the cache 11\_1 of the destination terminal 10\_1 stores the addresses of all the former node devices including the communication start node device 20\_3 having the areas to which it has moved until the present time, and notifies the former node devices including the communication start node device of the addresses of the latest node device and the destination terminal every time it moves to the area of the latest node device.

Hereinafter, detailed operations of the embodiment (7) will be described.

The state before the packet transfer operation is the same as the state before the operation of the embodiment (6).

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 stores the address [133.1.5] of the communication start node device 20\_3 in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the address [133.1.5] of the communication start node device 20\_3 to the network.

Step S4: The node device 20\_4 retrieves the address [133.1.1] of the location registering server 30\_1

corresponding to the address [1.1.1] of the terminal 10\_1  
from the server retrieval table 40.

Steps S5 and S6: The node device 20\_4 transmits the  
location registration information to the location  
5 registering server 30\_1 and notifies the address [133.1.6]  
of its own device and the address of the destination  
terminal to the node device 20\_3.

Step S7: The location registering server 30\_1 updates the  
address of the node device having the area where the  
10 terminal 10\_1 is located in the location registering table  
31\_1 to [133.1.6].

Step S8: The node device 20\_3 adds the address of the  
terminal 10\_1 and the address [133.1.6] of its destination  
node device to the location information table 22\_3.

15 Step S9: The terminal 10\_1 moves to the area 21\_5 of the  
node device 20\_5.

Step S10: The terminal 10\_1 stores the address [133.1.5]  
of the communication start node device 20\_3 and the address  
[133.1.6] of the former node device 20\_4 in the cache 11\_1.

20 Step S11: The terminal 10\_1 makes the location  
registration to the network. At this time, it notifies the  
address [133.1.5] of the communication start node device  
20\_3 and the address [133.1.6] of the former node device  
20\_4 to the network.

25 Steps S12 and S13: The node device 20\_5 retrieves the  
address [133.1.1] of the location registering server 30\_1  
corresponding to the address [1.1.1] of the terminal 10\_1  
from the server retrieval table 40 and transmits the  
location registration information to the location  
30 registering server 30\_1.

Step S14: The node device 20\_5 notifies the address

[133.1.7] of the node device 20\_5 and the address of the destination terminal to the node devices 20\_3 and 20\_4.

Step S15: The location registering server 30\_1 updates the address of the node device having the area where the  
5 terminal 10\_1 is located in the location registering table 31\_1 to [133.1.7].

Step S16: The node device 20\_3 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_3 to  
10 [133.1.7].

Step S17: The node device 20\_4 adds the address of the terminal 10\_1 and the address [133.1.7] of its destination node device to the location information table 22\_4.

Thus, the node devices 20\_3 and 20\_4 are to know the  
15 address of the node device having the area where the terminal 10\_1 is located at present.

Hereafter, when the node devices 20\_3 and 20\_4 receive the inter-node packet 81 addressed to the terminal 10\_1, they perform operations similar to steps S11-S13 of  
20 the embodiment (5) shown in Fig.10 and transfer the received packet 81 to the node device 20\_5.

Fig.13 shows the embodiment (8) of the node device according to the present invention which composes the communication system. The arrangement of this  
25 communication system is different from that of the embodiment (7) in Fig.12 in that the node devices 20\_4 and 20\_5 are respectively provided with storage portions 23\_4 and 23\_5 (hereinafter generally referred as a reference numeral "23").

Also, there is a difference that the storage portion  
30 11\_1 of the destination terminal 10\_1 stores only the

address of the destination node device having the area where the destination terminal was located immediately before moving.

5       The storage portions 23\_4 and 23\_5 of the node devices 20\_4 and 20\_5 store the address of the node device having the area where the destination terminal 10\_1 was located immediately before moving the area.

10       In this embodiment (8), schematically, the storage portion 11\_1 stores the address of the most recent former node device and the storage portion 23 of the latest node device stores this address.

15       Then, every time the destination terminal 10\_1 moves to the area of the new destination node device while the communication is continuing, the latest node device notifies the addresses of its own device and the destination terminal to the most recent former node device. The former node device notifies the addresses of the latest node device and the destination terminal to the previous former node device by referring to its own storage portion 20   23.

By repeating this, the address of the latest node device is notified to all of the node devices having the areas where the destination terminal 10\_1 was located.

25       Hereinafter, detailed operations of the embodiment (8) will be described. The state before the operations is the same as that of the embodiment (7).

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

30       Step S2: The terminal 10\_1 stores the address [133.1.5] of the former node device 20\_3 in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration

to the network. At this time, it notifies the address [133.1.5] of the communication start node device 20\_3 to the network.

5     Step S4: The terminal 10\_1 updates the cache 11\_1 to the address [133.1.6] of the destination node device 20\_4.

Step S5: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

10    Step S6: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

Step S7: The node device 20\_4 stores the address [1.1.1] of the terminal 10\_1 and the address [133.1.5] of the former node device 20\_3 in the cache 23\_4.

15    Step S8: The node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to the node device 20\_3.

Step S9: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

20    Step S10: The node device 20\_3 adds the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of its corresponding destination node device to the location information table 22\_3.

Step S11: The terminal 10\_1 moves to the area 21\_5 of the node device 20\_5.

Step S12: The terminal 10\_1 stores the address [133.1.6] of the former node device 20\_4 in the cache 11\_1.

30    Step S13: The terminal 10\_1 makes the location

registration to the network. At this time, it notifies the address [133.1.6] of the former node device 20\_4 to the network.

5     Step S14: The terminal 10\_1 updates the address of the cache 11\_1 to [133.1.7].

Step S15: The node device 20\_5 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

10    Step S16: The node device 20\_5 transmits the location registration information to the location registering server 30\_1.

Step S17: The node device 20\_5 stores the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of its  
15    corresponding former node device in the cache 23\_5.

Step S18: The node device 20\_5 notifies the address [133.1.7] of its own device and the address of the destination terminal to the node device 20\_4.

Step S19: The location registering server 30\_1 updates the  
20    address of the destination node device corresponding to the terminal 10\_1 in the location registering table 31\_1 to [133.1.7].

Step S20: The node device 20\_4 adds the address [1.1.1] of the terminal 10\_1 and the address [133.1.7] of its  
25    corresponding destination node device to the location information table 22\_4.

Step S21: The node device 20\_4 retrieves, from the cache 23\_4, the address [133.1.5] of the former node device having the area where the terminal 10\_1 was located.

30    Step S22: The node device 20\_4 notifies the address [133.1.7] of the node device 20\_5 and the address of the

destination terminal to the node device 20\_3.

Step S23: The node device 20\_3 updates the address of the destination node device corresponding to the terminal 10\_1 in the location information table 22\_3 to [133.1.7].

5        Thus, the node devices 20\_3 and 20\_4 respectively store, in the location information tables 22\_4 and 22\_3, the address [133.1.7] of the node device 20\_5 having the area where the destination terminal is located at present.

10       Hereafter, when the node devices 20\_3 and 20\_4 receive the inter-node packet 81 addressed to the terminal 10\_1, they perform operations of steps S13-S15 of the embodiment (6) shown in Fig.11 and the received packet 81 is directly transferred to the node device 20\_5 having the area where the destination terminal 10\_1 is located.

15       Fig.14 shows the embodiment (9) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is the same as that of the embodiment (5) in Fig.10 except that the destination terminal 10\_1 does not have the cache 11\_1.

20       The operations of this embodiment (9) are, schematically, different from those of the embodiment (5) where the cache 11\_1 stores the address of the former node device in that the address of the former node device is  
25       obtained from the location registration information of the destination terminal 10\_1 registered in the location registering server 30\_1 so that the former node device is notified of the addresses of the destination node device and the destination terminal.

30       Hereinafter, detailed operations of the embodiment (9) will be described.



The state of the communication system before the terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

- 5    Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the network.

- 10    Step S3: The node device 20\_4 retrieves the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1 from the server retrieval table 40.

- 15    Step S4: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

Step S5: The location registering server 30\_1 refers to the location registering table 31\_1 to retrieve the address [133.1.5] of the node device having the area where the terminal 10\_1 was located.

- 20    Step S6: The location registering server 30\_1 notifies the node device 20\_3 of the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located and the address of the destination terminal.

- 25    Step S7: The location registering server 30\_1 updates the address of the node device having the area where the destination terminal 10\_1 is located in the location registering table 31\_1 to the address [133.1.6] with which the location registration was made.

- 30    Step S8: The node device 20\_3 adds the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of its

destination node device to the location information table 22\_3.

Hereafter, the operations of steps S9-S13 of the embodiment (5) shown in Fig.10 are performed.

5 It is to be noted that as a varied example of this embodiment (9), the node device 20\_4 may transmit the addresses of its own device and the destination terminal in the above-mentioned steps S4-S7 as follows:

Before making the location registration of the  
10 destination terminal 10\_1, the node device 20\_4 transmits, to the location registering server 30\_1, a message inquiring the address of the destination node device having the area where the destination terminal 10\_1 was located to obtain the address [133.1.5] of the former node  
15 device 20\_3.

Then, based on this address, the node device 20\_4 directly transmits the address [133.1.6] of its own device and the address of the destination terminal to the former node device 20\_3.

20 Fig.15 shows the embodiment (10) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is the same as that of the embodiment (6) shown in Fig.11 except that the terminal 10\_1 does not  
25 maintain the storage portion 11\_1.

Schematically, in the previous embodiment (6), the address of the latest node device is notified to the node device 20\_3 every time the destination terminal 10\_1 moves to the latest node device based on the address [133.1.5]  
30 of the communication start node device 20\_3 stored in the destination terminal 10\_1.

On the other hand, in this embodiment (10), the location registering server 30\_1 stores the address [133.1.5] of the communication start node device 20\_3 and notifies the address of the latest node device and the address of the destination terminal to the communication start node device every time the destination terminal 10\_1 moves to the area of the latest node device.

Hereinafter, detailed operations of the embodiment (10) will be described.

10 The state of the communication system before the terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3 with which it has started the communication and the source node device 20\_2 stores the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

20 Step S2: The terminal 10\_1 makes the location registration to the network. At this time, it is notified that the communication is being continued.

Steps S3 and S4: The node device 20\_4 retrieves the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1 from the server retrieval table 40 and transmits the location registration information to the location registering server 30\_1. At this time, it is notified that the communication is being continued.

30 Step S5: The location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address

[133.1.5] of the node device having the area where the terminal 10\_1 was located.

Step S6: The location registering server 30\_1 notifies the address [133.1.6] of node device 20\_4 and the address of the destination terminal to the node device 20\_3. Since the communication is being continued at this time, the location registering table is not updated.

Step S7: The node device 20\_3 adds the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of the destination node device to the location information table 22\_3.

Step S8: The terminal 10\_1 moves to the area 21\_5 of the node device 20\_5.

Step S9-S13: Operations similar to steps S2-S6 are performed.

Step S14: The node device 20\_3 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_3 to [133.1.7].

Hereafter, operations similar to steps S11-S15 of the embodiment (6) in Fig.11 are performed and the node device 20\_3 directly transfers the packet 81 as the packet 82 to the node device 20\_5 having the area where the destination terminal 10\_1 is located.

Fig.16 shows the embodiment (11) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is different from that of the embodiment (10) in Fig.15 in that the location registering server 30\_1 is provided with the storage portion (cache) 32\_1 corresponding to each terminal and all of the

addresses of the former node devices are stored in this cache 32\_1.

Also, the location information table 22\_4 of the node device 20\_4 omitted in Fig.15 is shown in Fig.16.

5        Schematically, in the previous embodiment (10), the location registering server 30\_1 notifies the addresses of the destination node device and the destination terminal to the communication start node device 20\_3 while the communication is continuing. However, in this  
10        embodiment (11), the location registering server 30\_1 notifies the addresses of the latest node device and the destination terminal to all of the node devices having the areas where the destination terminal has been located every time the destination terminal 10\_1 moves to the  
15        latest node device.

Hereinafter, detailed operations of the embodiment (11) will be described. The state of the communication system before the terminal 10\_1 moves is the same as that of the embodiment (10).

20        Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the network. At this time, it is notified that the communication is being continued.

25        Step S3: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

30        Step S4: The node device 20\_4 transmits the location registration information to the location registering server 30\_1. At this time, it is notified that the

communication is being continued.

Steps S5 and S6: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location  
5 registering table 31\_1 to [133.1.6] and stores the address [133.1.5] of the former node device 20\_3 in the cache 32\_1 corresponding to the terminal 10\_1.

Step S7: The location registering server 30\_1 notifies the address [133.1.6] of the node device 20\_4 and the address  
10 of the destination terminal to the node device 20\_3.

Step S8: The node device 20\_3 adds the address [1.1.1] of the terminal 10\_1 and the address [133.1.6] of the destination node device to the location information table 22\_3.

15 Step S9: The terminal 10\_1 moves to the area 21\_5 of the node device 20\_5.

Step S10: The terminal 10\_1 makes the location registration to the network. At this time, it is notified that the communication is being continued.

20 Step S11: The node device 20\_5 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S12: The node device 20\_5 transmits the location  
25 registration information to the location registering server 30\_1. At this time, it is notified that the communication is being continued.

Step S13: The location registering server 30\_1 updates the destination node device address corresponding to the  
30 address [1.1.1] of the terminal 10\_1 in the location registering table 31\_1 to [133.1.7].

Step S14: The location registering server 30\_1 adds the address [133.1.6] of the former node device 20\_4 to the cache 32\_1 corresponding to the terminal 10\_1.

Step S15: The location registering server 30\_1 notifies  
5 the address [133.1.7] of the node device 20\_5 and the address of the destination terminal to the node devices 20\_3 and 20\_4 based on the cache 32\_1.

Steps S16 and S17: The node device 20\_3 updates the  
10 address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_3 to [133.1.7] and the node device 20\_4 adds the same to the location information table 22\_4.

Hereafter, when the inter-node packet 81 addressed  
15 to the terminal 10\_1 is received, the operations similar to steps S11-S15 of the embodiment (6) in Fig.11 are performed so that the node device 20\_3 directly transfers the packet 81 to the destination node device 20\_5.

Also, in the same way, the node device 20\_4 directly  
20 transfers the packet 81 to the node device 20\_5 when it receives the packet 81 addressed to the terminal 10\_1.

It is to be noted that as a varied example of this  
embodiment (11), although the node device 20\_4 in the  
above-mentioned steps S4-S7 transmits its own device  
25 address [133.1.6] and the address of the destination terminal to the former node device 20\_3 through the location registering server 30\_1, it may transmit the addresses of its own device and the destination terminal as follows:

Namely, the node device 20\_4 transmits an inquiry  
30 message for the address of the node device having the area where the destination terminal 10\_1 is located to the

location registering server 30\_1. The location registering server 30\_1 sends back the address [133.1.5] stored in the cache 32\_1 to the node device 20\_4.

Then, based on this address, the node device 20\_4 directly transmits the addresses of its own device and the destination terminal to the former node device 20\_3.

In the same way, instead of steps S12-S15, the latest node device 20\_5 transmits the inquiry message to the location registering server 30\_1, obtains the addresses [133.1.5] and [133.1.6] of the node devices 20\_3 and 20\_4, and transmits the address [133.1.7] of its own device and the address of the destination terminal to the node devices 20\_3 and 20\_4.

(iii) Embodiments of Method 1 for achieving Object 2  
(embodiment (12) of Fig.17-embodiment (15) of Fig.20)

These embodiments achieve Object 2 (reducing the occurrence of the source node device continuously transmitting the packet to the former node device having the area where the destination terminal has been located with the location information stored in the source node device not being updated in spite of the movement of the destination terminal) based on Method 1 (to update the location information of the destination terminal stored in the source node device when the packet arrives at the node device on the receiving side).

Fig.17 shows the embodiment (12) of the node device according to the present invention which composes the communication system. In the arrangement of this communication system, the node device 20\_3 is provided with the storage portion (for example cache) 23\_3 instead



of the cache 11\_1 in the destination terminal 10\_1 of the embodiment (5) shown in Fig.10. The storage portion 23\_3 can also be used as the location information table.

The cache 23\_3 stores the address [1.1.1] of the destination terminal 10\_1 and the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located made corresponding to each other.

It is to be noted that as operations of the cache 23\_3 before storing the address of the destination node device, for example, there are the embodiment (5) of Fig.10-the embodiment (11) of Fig.16.

Schematically, in this embodiment (12), the former node device 20\_3 notifies the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located and the address of the destination terminal to the source node device 20\_2.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

In the state before the source terminal 10\_4 transmits the packet 71, the the terminal 10\_1 moves from the area 21\_3 of the node device 20\_3 to the area 21\_4 of the node device 20\_4, address [133.1.6] is stored in the cache 23\_3, and the source node device 20\_2 stores the address [133.1.5] of the former node device 20\_3 having the area where the destination terminal 10\_1 was located in the location information table 22\_2.

Step S1-S3: The node device 20\_2 transfers to the node device 20\_3 the inter-node packet 81 which is the received packet 71, addressed to the terminal 10\_1 and added with the address [133.1.5] of the node device 20\_3.

Steps S4 and S5: The node device 20\_3 retrieves the cache

23\_3, obtains the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located, and notifies this address and the address of the destination terminal to the node device 20\_2.

- 5    Step S6: The node device 20\_2 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_2 to [133.1.6].

Thus, it becomes possible for the node device 20\_2  
10    to directly transfer the packet 71 addressed to the terminal 10\_1 to the node device 20\_4 having the area where the terminal 10\_1 is located.

Fig.18 shows the embodiment (13) of the node device according to the present invention which composes the  
15    communication system. The arrangement of this communication system is the same as that of the embodiment (1) shown in Fig.5.

In this embodiment (13), schematically, the former node device 20\_3 transfers the received inter-node packet  
20    81 to the location registering server 30\_1 to request this location registering server 30\_1 to notify the source node device 20\_2 of the address [133.1.6] of the destination node device 20\_4 and the address of the destination terminal.

25    Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

The state before the source terminal 10\_4 transmits the packet in Fig.18 is as follows:

The source node device 20\_2 stores the address  
30    [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information

table 22\_2.

The terminal 10\_1 moves from the area 21\_3 of the node device 20\_3 to the area 21\_4 of the node device 20\_4 and makes the location registration.

5       The location registering server 30\_1 updates the address of the node device corresponding to the address [1.1.1] of the terminal 10\_1 in the location registering table 31\_1 to the address [133.1.6] of the node device 20\_4.

10     Steps S1-S3: The node device 20\_2 adds the address [133.1.5] of the node device 20\_3 to the received user packet 71 addressed to the terminal 10\_1 and transfers the same as the inter-node packet 81.

15     Step S4: Since the destination terminal 10\_1 is not located in its area, the node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

20     Step S5: The node device 20\_3 transfers the inter-node packet 82, which has the destination address of received packet 81 rewritten to [133.1.1], to the location registering server 30\_1. At this time, the address of the source node device of the received packet 81 remains to be [133.1.4].

25     Step S6: The location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located.

30     Step S7: The location registering server 30\_1 notifies the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located and the address of the

destination terminal to the source node device 20\_2.

Step S8: The node device 20\_2 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_2 to

5 [133.1.6].

Thus, "the address of the destination node device" of the terminal 10\_1 in the location information table 22\_2 of the source node device 20\_2 is updated to the address [133.1.6] of the node device 20\_4 having the area where  
10 the terminal 10\_1 is actually located.

Hereafter, the source node device 20\_2 directly transfers the packet addressed to the terminal 10\_1 to the node device 20\_4.

Fig.19 shows the embodiment (14) of the node device  
15 according to the present invention which composes the communication system. The arrangement of this communication system is similar to that of the embodiment (13) shown in Fig.18.

In this embodiment (14), schematically a difference  
20 from the embodiment (13) is the node device 20\_3 on the receiving side requests the location registering server 30\_1 to notify the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located and the address of the destination terminal to  
25 the source node device 20\_2 instead of directly transferring the inter-node packet 82 to the location registering server 30\_1.

Then, the location registering server 30\_1 notifies the address [133.1.6] of the destination node device and  
30 the address of the destination terminal to the source node device 20\_2.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described. The state before the source terminal 10\_4 transmits the packet is the same as that of the embodiment (13).

5    Steps S1-S3: The node device 20\_2 transfers the inter-node packet 81 which has the address [133.1.5] of the node device 20\_3 added to the received packet 71.

10    Step S4: Since the destination terminal 10\_1 is not located in its area, the node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

15    Step S5: The node device 20\_3 transmits the message which requests to notify the source node device 20\_2 of the address of the node device having the area where the terminal 10\_1 is located and the address of the destination terminal to the location registering server 30\_1.

20    Steps S6 and S7: The location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located and notifies the address [133.1.6] and the address of the destination terminal to the source node device 20\_2.

25    Step S8: The node device 20\_2 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_2 to [133.1.6].

30    Thus, it becomes possible for the node device 20\_2 to directly transfer the packet 71 addressed to the terminal 10\_1 to the node device 20\_4 having the area where the terminal 10\_1 is located, as in the embodiment (13).

Fig.20 shows the embodiment (15) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is similar to that of the embodiment (14) shown in Fig.19.

In this embodiment (15), schematically, the node device 20\_3 on the receiving side, different from the embodiment (14), obtains the address [133.1.6] from the location registering server 30\_1 and transfers the same to the source node device 20\_2 instead of requesting the location registering server 30\_1 to notify the address [133.1.6] of the destination node device and destination terminal to the source node device.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described. The state before the source terminal 10\_4 transmits the packet is the same as that of the embodiment (14).

Steps S1-S3: The node device 20\_2 transfers to the node device 20\_3 the inter-node packet 81 which is the received packet 71, addressed to the terminal 10\_1 and added with the address [133.1.5] of the node device 20\_3.

Step S4: Since the destination terminal 10\_1 is not located in the area 21\_3, the node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S5: The node device 20\_3 transmits the message inquiring the address of the node device having the area where the terminal 10\_1 is located to the location registering server 30\_1.

Steps S6 and S7: The location registering server 30\_1

retrieves the location registering table 31\_1 to obtain the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located and notifies the same to the node device 20\_3.

5 Step S8: The node device 20\_3 notifies the address [133.1.6] and the address of the destination terminal to the node device 20\_2.

Step S9: The node device 20\_2 updates the address of the node device having the area where the terminal 10\_1 is  
10 located in the location information table 22\_2 to [133.1.6].

Thus, it becomes possible for the node device 20\_2 to directly transfer a packet addressed to the terminal 10\_1 to the node device 20\_4 having the area where the  
15 terminal 10\_1 is located as in the embodiment (14).

(iv) Embodiments of Method 2 for achieving Object 2  
(embodiment (16) of Fig.21-embodiment (22) of Fig.27)

These embodiments achieve Object 2 (reducing the  
20 occurrence of the source node device from continuously transmitting the packet to the former node device having the area where the destination terminal has been located with the location information stored in the source node device not being updated in spite of the movement of the  
25 destination terminal) based on Method 2 (to update the location information of the destination terminal stored in the source node device when the destination terminal has moved to another area).

Fig.21 shows the embodiment (16) of the node device  
30 according to the present invention which composes the communication system. The arrangement of this

communication system is similar to that of the embodiment (5) shown in Fig.10. However, it is different from the embodiment (5) in that the storage portion (for example cache) 11\_1 of the destination terminal 10\_1 stores the address of the source node device instead of the address of the former node device.

In this embodiment (16), schematically, the node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to the source node devices all at once based on the addresses stored in the cache 11\_1 when the destination terminal 10\_1 has moved to its own area 21\_4.

It is possible that a terminal generally performs a packet communication simultaneously with a plurality of terminals. However, in the embodiments (1)-(15), the packet communication from a single source terminal to a single destination terminal has been described as an example for simplicity.

In this embodiment (16) and in the embodiments (17)-(22) to be described later, the case where the destination terminal 10\_1 is communicating simultaneously with the source terminals 10\_3 and 10\_4 will be described.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

The state of the communication system before the destination terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

The source node devices 20\_1 and 20\_2 respectively store the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location



information tables 22\_1 and 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 stores the addresses [133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2 having the areas where the source terminals 10\_3 and 10\_4 are respectively located in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the addresses [133.1.3] and [133.1.4] to the network.

Step S4: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S5: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

Steps S6 and S7: The node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to each of the node devices 20\_1 and 20\_2.

Step S8: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Steps S9 and S10: The node devices 20\_1 and 20\_2 respectively update the address of the node device having the area where the terminal 10\_1 is located in the location information tables 22\_1 and 22\_2 to [133.1.6].

Hereafter, the node devices 20\_1 and 20\_2 directly transfer the packets addressed to the terminal 10\_1 to the

node device 20\_4 having the area to which the terminal 10\_1 has moved.

Fig.22 shows the embodiment (17) of the node device according to the present invention which composes the communication system. The arrangement of this communication system is similar to that of the embodiment (16) shown in Fig.21. However, it differs from the embodiment (16) in that the cache 11\_1 of the destination terminal 10\_1 stores the address of the source terminal instead of storing the address of the source node device.

In this embodiment (17), schematically, the node device 20\_4 indirectly notifies the address [133.1.6] of its own device and the address of the destination terminal to the source node device through the location registering server based on the address stored in the cache 11\_1 of the terminal 10\_1 when the destination terminal 10\_1 has moved to its own area 21\_4.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

The state of the communication system before the destination terminal 10\_1 moves is the same as that of the embodiment (16).

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 stores the address [2.1.1] of the source terminal 10\_3 and the address [2.2.1] of the source terminal 10\_4 in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the address [2.1.1] of the source terminal 10\_3 and the address [2.2.1] of the source terminal 10\_4 to the network.

- Step S4: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.
- 5    Step S5: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.1.1] of the source terminal 10\_3
- 10    Step S6: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.2.1] of the source terminal 10\_4. It is to be noted that at this time, depending on the address of the source terminal, there are cases where a location
- 15    registering server different from the one in step S5 is retrieved.
- Step S7: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.
- 20    Step S8: The node device 20\_4 transmits a message to the location registering server 30\_2 in order to have the address [133.1.6] of its own device and the address of the destination terminal notified to the node device 20\_1 having the area where the source terminal 10\_3 is located.
- 25    Step S9: The node device 20\_4 transmits a message to the location registering server 30\_2 in order to have the address [133.1.6] of its own device and the address of the destination terminal notified to the node device 20\_2 having the area where the source terminal 10\_4 is located.
- 30    Step S10: The location registering server 30\_1 updates the address of the node device having the area where the

terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Step S11: The location registering server 30\_2 retrieves the location registering table 31\_2 to obtain the address  
5 [133.1.3] of the node device having the area where the source terminal 10\_3 is located.

Step S12: The location registering server 30\_2 retrieves the location registering table 31\_2 to obtain the address  
10 [133.1.4] of the node device having the area where the source terminal 10\_4 is located.

Steps S13 and S14: The location registering server 30\_2 notifies the address [133.1.6] of the node device 20\_4 and the address of the destination terminal to each of the node devices 20\_1 and 20\_2.

15 Steps S15 and S16: The node devices 20\_1 and 20\_2 update the address of the destination node device corresponding to the terminal 10\_1 respectively in the location information tables 22\_1 and 22\_2 to [133.1.6].

Thus, the source node devices 20\_1 and 20\_2 are to  
20 know the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located, so that hereafter, the packet addressed to the destination terminal 10\_1 can be directly transferred to the node device 20\_4.

25 Fig.23 shows the embodiment (18) of the node device according to the present invention which composes the communication system. The arrangement of this communication system similar to that of the embodiment (16) shown in Fig.21 except that the destination terminal  
30 10\_1 is not provided with the cache 11\_1.

Also, it is different in that the node device 20\_3

is provided with the storage portion (for example cache) 23\_3, which stores the addresses [133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2 having the areas where the source terminals 10\_3 and 10\_4 are respectively  
5 located.

In this embodiment (19), schematically, when the destination terminal 10\_1 has moved to the area 21\_4, the node device 20\_4 indirectly notifies the address [133.1.6] of its own device and the address of the destination  
10 terminal to the source node devices 20\_1 and 20\_2 through the location registering server and the former node device 20\_3.

Hereinafter, the detailed operations after the destination terminal 10\_1 has moved will be described.

15 The state of the communication system before the destination terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

The location information tables 22\_1 and 22\_2  
20 respectively store the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

The cash 23\_3 stores the addresses [133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2 having the  
25 areas where the source terminals 10\_3 and 10\_4 of the destination terminal 10\_1 are respectively located.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration  
30 to the network.

Step S3: The node device 20\_4 retrieves the server

retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S4: The node device 20\_4 transmits the location registration information to location registering server 30\_1.

Steps S5 and S6: The location registering server 30\_1 retrieves the location registering table 31\_1, obtains the address [133.1.5] of the node device having the area where the terminal 10\_1 was located, and notifies the address [133.1.6] of the destination node device and the address of the destination terminal to the former node device 20\_3 of this address [133.1.5].

Step S7: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Steps S8-S10: The node device 20\_3 notifies the address [133.1.6] of node device 20\_4 and the address of the destination terminal to the node devices 20\_1 and 20\_2.

Steps S11 and S12: The node devices 20\_1 and 20\_2 respectively update the address of the node device having the area where the terminal 10\_1 is located in the location information tables 22\_1 and 22\_2 to [133.1.6].

Thus, the source node devices 20\_1 and 20\_2 are to know the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located, so that hereafter, it becomes possible for the packet addressed to the destination terminal 10\_1 to be directly transferred to the node device 20\_4.

Fig.24 shows the embodiment (19) of the node device

according to the present invention which composes the communication system. The arrangement of this communication system is similar to that of the embodiment (18) shown in Fig.23. However, it is different in that the  
5 terminal 10\_1 is further provided with the storage portion 11\_1 for storing the address of the former node device.

In this embodiment (19), schematically, when the destination terminal 10\_1 has moved to the area 21\_4, the node device 20\_4 notifies the address [133.1.6] of its own  
10 device and the address of the destination terminal to the source node devices 20\_1 and 20\_2 through the former node device 20\_3 based on the address stored in the cache 11\_1 of the terminal 10\_1.

Hereinafter, detailed operations after the  
15 destination terminal 10\_1 has moved will be described.

The state of the communication system before the destination terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

20 The cache 23\_3 stores the address [133.1.3] of the node device 20\_1 having the area where the source terminal 10\_3 of the terminal 10\_1 is located and the address [133.1.4] of the node device 20\_2 having the area where the source terminal 10\_4 is located.

25 The source node devices 20\_1 and 20\_2 respectively store the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information tables 22\_1 and 22\_2.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the  
30 node device 20\_4.

Step S2: The terminal 10\_1 stores the address [133.1.5]

of the former node device 20\_3 in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the address [133.1.5] of the former node device 20\_3 to the network.

5    Steps S4 and S5: The node device 20\_4 retrieves the server retrieval table 40, obtains the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1, and transmits the location registration information to the location  
10    registering server 30\_1.

Step S6: The node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to the node device 20\_3.

Step S7: The location registering server 30\_1 updates the  
15    address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Steps S8-S10: The node device 20\_3 refers to the cache 23\_3 to notify the address [133.1.6] of the node device 20\_4 and the address of the destination terminal to the node  
20    devices 20\_1 and 20\_2.

Steps S11 and S12: The node devices 20\_1 and 20\_2 respectively update the address of the node device having the area where the terminal 10\_1 is located in the location  
25    information tables 22\_1 and 22\_2 to [133.1.6].

Thus, the node devices 20\_1 and 20\_2 respectively store the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located in the location information tables 22\_1 and 22\_2.

30    Hereafter, it becomes possible for the node devices 20\_1 and 20\_2 to directly transfer the packet addressed



to the terminal 10\_1 to the node device 20\_4.

Fig.25 shows the embodiment (20) of the node device according to the present invention which composes the communication system. This embodiment (20) is different  
5 from the embodiment (19) shown in Fig.24 in that the cache 23\_3 of the node device 20\_3 stores the addresses [2.1.1] and [2.2.1] of the source terminals instead of storing the addresses [133.1.3] and [133.1.4] of the source node devices 20\_1 and 20\_2.

10 In this embodiment (20), schematically, when the destination terminal 10\_1 has moved to the area 21\_4, the node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to the source node devices 20\_1 and 20\_2 through the former node  
15 device 20\_3 and the location registering server 30\_2 based on the addresses stored in the caches 11\_1 and 23\_3.

Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

The state of the communication system before the  
20 destination terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3. The cache 23\_3 stores the addresses [2.1.1] and [2.2.1] of the source terminals 10\_3 and 10\_4 of the terminal 10\_1. The location information tables 22\_1  
25 and 22\_2 respectively store the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

30 Step S2: The terminal 10\_1 stores the address [133.1.5] of the former node device 20\_3 in the cache 11\_1.

Step S3: The terminal 10\_1 makes the location registration to the network. At this time, it notifies the address [133.1.5] of the former node device 20\_3 to the network.

5 Steps S4 and S5: The node device 20\_4 retrieves the server retrieval table 40, obtains the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1, and transmits the location registration information to the location registering server 30\_1.

10 Step S6: The node device 20\_4 notifies the address [133.1.6] of its own device and the address of the destination terminal to the node device 20\_3.

Step S7: The location registering server 30\_1 updates the address of the node device having the area where the  
15 terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

Steps S8-S10: The node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the  
20 address [2.1.1] of the source terminal 10\_3 stored in the cache 23\_3.

In the same way, the node device 20\_3 obtains the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.2.1] of the source  
25 terminal 10\_4.

Step S11: The node device 20\_3 transmits a message to the location registering server 30\_2, and requests with this message the location registering server 30\_2 to notify the address [133.1.6] of the node device 20\_4 having the area  
30 where the terminal 10\_1 is located and the address of the destination terminal to the node device 20\_1 having the

area where the source terminal 10\_3 is located.

Step S12: Similarly, the node device 20\_3 requests the location registering server 30\_2, with a message, to notify the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located and the address of the destination terminal to the node device 20\_2 having the area where the source terminal 10\_4 is located.

Steps S13 and S14: The location registering server 30\_2 retrieves the location registering table 31\_2 and obtains the addresses [133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2 having the area where the source terminals 10\_3 and 10\_4 are respectively located.

Steps S15 and S16: The location registering server 30\_2 notifies the address [133.1.6] of node device 20\_4 and the address of the destination terminal to each of the node devices 20\_1 and 20\_2.

Steps S17 and S18: The node devices 20\_1 and 20\_2 respectively update the address of the node device having the area where the destination terminal 10\_1 is located in the location information tables 22\_1 and 22\_2 to [133.1.6].

Thus, the node devices 20\_1 and 20\_2 respectively know the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located, so that hereafter it becomes possible for them to directly transfer the packet addressed to the terminal 10\_1 to the node device 20\_4.

Fig.26 shows the embodiment (21) of the node device according to the present invention which composes the communication system. This embodiment (21) is different from the embodiment (18) shown in Fig.23 in that the

location registering table 31\_1 of the location  
registering server 30\_1 is provided with a storage portion  
(for example cache) 32\_1 corresponding to each of the  
destination terminals while the node device 20\_3 is not  
5 provided with the cache 23\_3.

This cache 32\_1 stores, for example, the addresses  
[133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2  
having the areas where the source terminals 10\_3 and 10\_4,  
with which the destination terminal 10\_1 of the address  
10 [1.1.1] registered in the location registering table 31\_1  
is communicating, are located.

In this embodiment (21), schematically, when the  
destination terminal 10\_1 moves to the area 21\_4, the node  
device 20\_4 requests, for example, to the location  
15 registering server 30\_1 to notify the address [133.1.6]  
of its own device and the address of the destination  
terminal to the source node devices 20\_1 and 20\_2 based  
on the address stored in the cache 32\_1.

Hereinafter, detailed operations after the  
20 destination terminal 10\_1 has moved will be described.

The state of the communication system before the  
destination terminal 10\_1 moves is as follows:

The terminal 10\_1 is located in the area 21\_3 of the  
node device 20\_3.

25 The source node devices 20\_1 and 20\_2 respectively  
store the address [133.1.5] of the node device 20\_3 having  
the area where the terminal 10\_1 is located in the location  
information tables 22\_1 and 22\_2.

The cache 32\_1 of the location registering server  
30 30\_1 stores the addresses [133.1.3] and [133.1.4] of the  
node devices 20\_1 and 20\_2 having the areas where the

source terminals 10\_3 and 10\_4 of the terminal 10\_1 are respectively located. Method by which the cache 32\_1 stores the addresses of the source node devices will be described later referring to Fig.30.

- 5    Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the network.

- 10   Step S3: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

- 15   Step S4: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

Step S5: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

- 20   Steps S6-S8: The location registering server 30\_1 notifies the address [133.1.6] of node device 20\_4 and the address of the destination terminal to each of the node devices 20\_1 and 20\_2 of the addresses [133.1.3] and [133.1.4] stored in the cache 32\_1.

- 25   Steps S9 and S10: The node devices 20\_1 and 20\_2 respectively update the address of the node device having the area where the terminal 10\_1 is located in the location information tables 22\_1 and 22\_2 to [133.1.6].

- 30          Thus, the node devices 20\_1 and 20\_2 are to know the address [133.1.6] of the node device 20\_4 having the area where the destination terminal 10\_1 is located, so that

hereafter, it becomes possible for them to directly transfer the packet addressed to the terminal 10\_1 to the node device 20\_4.

5 In a varied example of this embodiment (21), the node device 20\_4 transmits, to the location registering server 30\_1, a message inquiring the addresses of the node devices, with which the destination terminal 10\_1 located in the area 21\_4 is communicating.

10 Then, the location registering server 30\_1 retrieves the storage portion 32\_1 and sends back the addresses [2.1.1] and [2.2.1].

15 The node device 20\_4 may obtain the addresses [133.1.3] and [133.1.4] of the node devices 20\_1 and 20\_2 having the area where the terminals of the addresses [2.1.1] and [2.2.1] are located from the location registering server 30\_2 and may directly transmit the address [133.1.6] of its own device and the address of the destination terminal to the node devices 20\_1 and 20\_2.

20 Fig.27 shows the embodiment (22) of the node device according to the present invention which composes the communication system. This embodiment (22) is different from the embodiment (21) shown in Fig.26 in that the cache 32\_1 stores the addresses of the source terminals instead of storing the addresses of the source node devices  
25 corresponding to the destination terminal.

Also, it is different in that the location registering server 30\_1 further has the server retrieval table 40.

30 In this embodiment (22), schematically, when the destination terminal 10\_1 moves to the area 21\_4, the node device 20\_4 requests the location registering server 30\_1

to notify the address [133.1.6] of its own device and the address of the destination terminal to the source node devices 20\_1 and 20\_2 based on the addresses stored in the cache 32\_1.

5           Although the operations of this embodiment (22) similar to those of the embodiment (21), they are different from the operations of the embodiment (21) since the addresses stored in the cache 32\_1 are mutually different.

10           Hereinafter, detailed operations after the destination terminal 10\_1 has moved will be described.

          The state of the communication system before the destination terminal 10\_1 moves in Fig.27 is as follows:

          The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

15           The location information tables 22\_1 and 22\_2 respectively store the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

20           The cache 32\_1 stores the addresses [2.1.1] and [2.2.1] of the source terminals 10\_3 and 10\_4 of the terminal 10\_1. It is to be noted that the method by which the cache 32\_1 stores the addresses of the source terminals will be described later referring to Fig.30.

25           Step S1: The terminal 10\_1 moves to the area 21\_4 of the node device 20\_4.

Step S2: The terminal 10\_1 makes the location registration to the network.

30           Step S3: The node device 20\_4 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S4: The node device 20\_4 transmits the location registration information to the location registering server 30\_1.

5 Step S5: The location registering server 30\_1 updates the address of the node device having the area where the terminal 10\_1 is located in the location registering table 31\_1 to [133.1.6].

10 Step S6: The location registering server 30\_1 stores the address [2.1.1] of the source terminal 10\_3 of the terminal 10\_1 and the address [2.2.1] of the source terminal 10\_4 in the cache 32\_1.

15 Step S7: The location registering server 30\_1 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.1.1] of the terminal 10\_3.

Step S8: The location registering server 30\_1 retrieves the server retrieval table 40 to obtain the address [133.1.2] of the location registering server 30\_2 corresponding to the address [2.2.1] of the terminal 10\_4.

20 Step S9: The location registering server 30\_1 transmits a message to the location registering server 30\_2 and requests to notify, with this message, the address of the node device having the area where the terminal 10\_1 is located and the address of the destination terminal to the  
25 node device having the area where the source terminal 10\_3 of the address [2.1.1] is located.

Step S10: The location registering server 30\_1 transmits a message to the location registering server 30\_2 and requests to notify, with this message, the address of the  
30 node device having the area where the terminal 10\_1 is located and the address of the destination terminal to the



node device having the area where the source terminal 10\_4  
of the address [2.2.1] is located

Steps S11 and S12: The location registering server 30\_2  
retrieves the location registering table 31\_2 to obtain  
5 the addresses [133.1.3] and [133.1.4] of the node devices  
having the areas where the source terminals 10\_3 and 10\_4  
are respectively located.

Steps S13 and S14: The location registering server 30\_2  
notifies the address [133.1.6] of the node device 20\_4 and  
10 the address of the destination terminal to each of the node  
devices 20\_1 and 20\_2.

Steps S15 and S16: The node devices 20\_1 and 20\_2  
respectively update the address of the node device having  
the area where the terminal 10\_1 is located in the location  
15 information tables 22\_1 and 22\_2 to [133.1.6].

Thus, the node devices 20\_1 and 20\_2 are to know the  
address [133.1.6] of the node device 20\_4 having the area  
where the destination terminal 10\_1 is located, so that  
hereafter, it becomes possible for them to directly  
20 transfer the packet addressed to the terminal 10\_1 to the  
node device 20\_4.

In a varied example of this embodiment (22), the node  
device 20\_4 may transmit the addresses of its own device  
and the destination terminal at steps S4-S14 as follows:

25 The node device 20\_4 transmits a message inquiring  
the addresses of the source terminals 10\_3 and 10\_4 to the  
location registering server 30\_1. The location  
registering server 30\_1 sends back the addresses [2.1.1]  
and [2.2.1] stored in the cache 32\_1 to the node device  
30 20\_4.

Then, the node device 20\_4 transmits a message

inquiring the node devices having the areas where the terminals of the addresses [2.1.1] and [2.2.1] are located to the location registering server 30\_2. The location registering server 30\_2 sends back the addresses [133.1.3] and [133.1.4] to the node device 20\_4.

Based on these addresses [133.1.3] and [133.1.4], the node device 20\_4 directly transmits the address [133.1.6] of its own device and the address of the destination terminal to the source node devices 20\_1 and 20\_2.

It is to be noted that in this varied example, the location registering servers 30\_1 and 30\_2 do not require the server retrieval table 40.

#### (v) Other embodiments

Fig.28 shows the embodiment (23) of the node device according to the present invention which composes the communication system. This embodiment (23) is the embodiment in which the embodiment (1) shown in Fig.5 and the embodiment (13) shown in Fig.18 are combined and the arrangement of the communication system is similar to that of the embodiment (13).

In this embodiment (23), schematically, the node device on the receiving side transmits the packet 81 (packet 71) and a message to the location registering server. With this message, the node device on the receiving side requests to transfer the packet 71 to the destination node device and to notify the address of the node device having the area where the destination terminal is located at present to the source node device.

Hereinafter, detailed operations after the

destination terminal 10\_1 has moved will be described.

The state of the communication system before the destination terminal 10\_1 has moved in Fig.28 is as follows:

5       The terminal 10\_1 is located in the area 21\_3 of the node device 20\_3.

10       The source node device 20\_2 stores the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located in the location information table 22\_2.

Step S1: The user packet 71 addressed to the terminal 10\_1 arrives at the node device 20\_2.

15       Step S2: The node device 20\_2 retrieves the location information table 22\_2 to obtain the address [133.1.5] of the node device 20\_3 having the area where the terminal 10\_1 is located.

20       Step S3: The node device 20\_2 transfers the inter-node packet 81 which has the address [133.1.5] of node device 20\_3 added to the received packet 71 addressed to the terminal 10\_1.

25       Step S4: Since the destination terminal 10\_1 is not located in the area, the node device 20\_3 retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.

Step S5: The node device 20\_3 transfers the inter-node packet 82 including the packet 71 addressed to the terminal 10\_1 and the message information to the location registering server 30\_1.

30       Fig.29 shows a detailed example of the packet 82, the format of which is the same as that of the packet 82 shown

in Fig.8.

In the fields 91 and 92, the address [133.1.1] of the location registering server 30\_1 which is the destination of the packet 82 and the address [133.1.5] of the node device 20\_3 which is the source of the packet 82 are respectively presented.

In the fields 93 and 94, the address [133.1.1] of the location registering server 30\_1 which is the destination of the message packet 90 and the address [133.1.5] of the node device 20\_3 which is the source of the message are respectively presented.

In the message information field 95, "Existence of user packet"="Exist", and "Message classification"="Notification of location information with notification destination node address being [133.1.4]" are presented.

Step S6: The location registering server 30\_1 recognizes that the message packet 90 is addressed to the server 30\_1 itself since the field 93 of the packet 82 received from the node device 20\_3 is the address [133.1.1] of the server 30\_1 itself.

Therefore, the location registering server 30\_1 reads the contents of the message information field 95 and recognizes that the user packet 71 addressed to the terminal 10\_1 is included in the message packet 90.

Then, the location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 of address [1.1.1] in the destination address field 96 included in the packet 71 is located.  
Step S7: The location registering server 30\_1 transfers

the inter-node packet 83, which is the user packet 71, addressed to the terminal 10\_1 and added with the address [133.1.6] of the node device 20\_4, to the node device 20\_4.

5 Step S8: Moreover, the location registering server 30\_1 recognizes that "Message classification" in the message information field 95 is "Notification of location information" and its notification destination node address is "Address [133.1.4]".

10 Therefore, the location registering server 30\_1 transmits the message to notify the address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located and the address of the destination terminal to the node device 20\_2.

15 Step S9: The node device 20\_2 updates the address of the node device having the area where the terminal 10\_1 is located in the location information table 22\_2 to [133.1.6].

20 Thus, the packet 71 is transferred to the destination terminal 10\_1 through the node device 20\_4. Also, the node device 20\_2 is to know the address of the node device 20\_4 having the area where the destination terminal 10\_1 is located.

25 Hereafter, it becomes possible for the node device 20\_2 to directly transfer the packet 71 addressed to the terminal 10\_1 to the node device 20\_4.

30 Fig.30 shows procedures by which the storage portions of the destination terminal, the node device, and the location registering servers respectively store the addresses of the source node devices or the source terminals for example in the embodiments (16), (18), (19), and (21).

Also, it shows procedures by which the storage portions of the destination terminal, the node device, and the location registering servers respectively store the addresses of the source terminals for example in the  
5 embodiments (17), (20), and (22), respectively.

As an example of procedures, Fig.30 shows procedures by which the storage portion 11\_1 of the destination terminal 10\_1, the storage portion 23\_4 of the node device 20\_4 having the area where the destination terminal 10\_1 is located, and the storage portion 32\_1 of the location registering server 30\_1 corresponding to the destination terminal 10\_1 store the address [2.2.1] of the source terminal 10\_4 or the address [133.1.4] of the source node device 20\_2 when the source terminal 10\_4 transmits the  
10 packet 71 to the address terminal 10\_1.  
15

It is to be noted that the arrangement of the communication system of Fig.30 is similar to that of the system of Fig.21.

Step S1: The user packet 71 transmitted from the source terminal 10\_4 to the destination terminal 10\_1 arrives at the node device 20\_2.  
20

Step S2: Since the node device 20\_2 does not know the address of the node device having the area where the destination terminal 10\_1 is located, it retrieves the server retrieval table 40 to obtain the address [133.1.1] of the location registering server 30\_1 corresponding to the address [1.1.1] of the terminal 10\_1.  
25

Step S3: The node device 20\_2 transfers to the location registering server 30\_1 the inter-node packet 81, which is the received packet 71, addressed to the terminal 10\_1 and added with the address [133.1.1] of location  
30

registering server 30\_1.

Step S4: The location registering server 30\_1 retrieves the location registering table 31\_1 to obtain the address [133.1.6] of the node device 20\_4 having the area where  
5 the terminal 10\_1 is located.

Step S5: At this time, the location registering server 30\_1 can store the address [2.2.1] of the source terminal 10\_4 in the storage portion 32\_1 by examining the source address of the packet 71.

10 Also, the location registering server 30\_1 can store the address [133.1.4] of the node device 20\_2 having the area where the source terminal 10\_4 is located in the storage portion 32\_1 by examining the source address of the packet 81.

15 Step S6: The location registering server 30\_1 transfers the inter-node packet 82, which has the destination address of the received packet 81 rewritten to [133.1.6], to the node device 20\_4.

Step S7: The location registering server 30\_1 notifies the  
20 address [133.1.6] of the node device 20\_4 having the area where the terminal 10\_1 is located to node device 20\_2 based on the source address [133.1.4] of the packet 81.

Step S8: The node device 20\_2 adds the address of the terminal 10\_1 and the address [133.1.6] of its destination  
25 node device to the location information table 22\_2.

Step S9: The node device 20\_4 can store the address [2.2.1] of the source terminal 10\_4 in the storage portion 23\_4 by examining the source address of the packet 71 included in the received packet 82.

30 Also, the node device 20\_4 can store the address [133.1.4] of the node device 20\_2 having the area where

the source terminal 10\_4 is located in the storage portion 23\_4 by examining the source address of the received inter-node packet 82.

Step S10: When notifying the address [133.1.4] of the node device 20\_2 having the area where the source terminal 10\_4 is located to the destination terminal 10\_1, the node device 20\_4 transmits a notification message including the address [133.1.4] of the node device 20\_2.

Step S11: The node device 20\_4 transmits the packet 71 from the source terminal 10\_4 to the destination terminal 10\_1.

Step S12: The destination terminal 10\_1 can store the address [133.1.4] of the node device 20\_2 included in the received notification message in the storage portion 11\_1.

Also, the destination terminal 10\_1 receives the user packet 71 transmitted from the source terminal 10\_4. At this time, the destination terminal 10\_1 can store the address [2.2.1] of the source terminal 10\_4 in the storage portion 11\_1 by examining the source address of the user packet 71.

Thus, the storage portions 11\_1, 23\_4, and 32\_1 respectively store the address [2.2.1] of the source terminal 10\_4 or the address [133.1.4] of the source node device 20\_2.

Fig.31 shows the embodiment (25) of the node device according to the present invention which composes the communication system. In this embodiment (25), the node devices 20\_1-20\_5 and the location registering servers 30\_1 and 30\_2 (hereinafter the node devices 20\_1-20\_5 and the location registering servers 30\_1 and 30\_2 are generally referred to as node device) are connected by ATM-SW's 60\_1-60\_3 (ATM switches).



Addresses [1]-[7] are assigned to each of the node devices 30\_1, 30\_2, and 20\_1-20\_5. VPI/VCI addresses, E.164 addresses, IPv4 addresses, IPv6 addresses, or the like can be used as the addresses [1]-[7].

5        Thus, even in the communication system where a general ATM network is applied to the network between the node devices, it is possible to perform a similar packet transfer operation to those of the embodiments (1)-(23) by replacing the IP addresses [133.1.1]-[133.1.7] of the  
10 node devices, in the embodiment (1) of Fig.5 - the embodiment (23), with the addresses [1]-[7] of the respective node devices in the ATM network.

Particularly, when the node devices are connected with ATM-SVC (Switched Virtual Connection), cases may be  
15 expected where the address of the node device that is the source of the inter-node packet cannot be recognized only by the ATM header information. In such cases, the method of the embodiment (3) shown in Figs.7 and 8 is useful.

As described above, a node device according to the  
20 present invention is arranged such that a node device on a receiving side transfers, to a destination node device, a received inter-node packet, based on destination terminal location information of its storage portion or a location registering server, directly or through other  
25 devices, or the destination node device notifies a former node device (on the receiving side) of an address of its own device directly or through other devices. Therefore, it becomes possible to reduce deterioration of a communication quality caused by a packet loss which occurs  
30 when the destination terminal moves to an area of another node device.

Also, the node device according to the present invention is arranged such that the node device on the receiving side or the destination node device notify a source node device of the address of the destination node device directly or through other devices, based on a predetermined address stored in the storage portion of the terminal, the node device, or the location registering server. Therefore, it becomes possible for the source node device to correctly transfer the packet to the destination node device without continuing to transmit the packet to the former node device having the area where the destination terminal was located with the stored location information not being updated.